ACTA UNIVERSITATIS SZEGEDIENSIS

PARS CLIMATOLOGICA SCIENTIARUM NATURALIUM

CURAT: G. PÉCZELY

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TOMUS XVI—XVII.

FASC. 1—4

SZEGED (HUNGARIA)

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TEMPORAL VARIABILITY OF MONTHLY MEAN PRESSURE VALUES ON THE EARTH

by

G. Péczely

A légnyomás havi középértékeinek időbeli változékonysága a Földön. A tanulmány 96 állomás 1951—1978 közötti légnyomási adatsorai alapján a légnyomás havi közepeinek szórását elemzi. A szórások havi értékeit táblázatos összeállítás tartalmazza. Megállapítja a szórás és a földrajzi szélesség közötti kapcsolatot, térképezi a maximális és minimális szórások bekövetkezési idejét, és két hónapra a szórás földgömbi eloszlását.

This study analyses the standard deviation of monthly mean values of pressure on the basis of data obtained from 96 stations and measured from 1951 to 1978. The monthly values of standard deviations are indicated on a table assembley. It states the connection between standard deviation and latitude, plots a map of appearence dates of maximal and minimal standard deviations and the standard deviation distribution on the Earth.

The territorial structure of the variability of climatic elements appears as a result of different atmospherical phenomena. A study of the global distribution of statistical parameters characterising variability forms for this reason an integral part of climatology.

Present study analyses the standard deviation of monthly mean values of pressure. The data base of this examination was formed by time arrays of monthly mean values of pressure corrected to sea-level measured at 96 stations which are relatively uniformly distributed on the entire surface of the Earth, and obtained during 28 years between 1951 and 1978. The pressure data arrays were compiled on the basis of the monthly pressure maps of the volumes of "World Weather Records" series (1951—1960) and "Die Witterung im Übersee" publication, respectively.

The

$$\sigma = \sqrt{\frac{n}{n-1} \frac{\sum_{i=1}^{n} (x_i - M)^2}{n}}$$

standard deviation values were calculated for each month and station, where x means the monthly mean values of pressure corrected to sea-level of a concrete station referring to a concrete year, M is the mean value of x value n is the number of observations, from which M mean values was obtained. Standard deviation values appear on *Table 1.*

The monthly mean values of standard deviation show a characteristical yearly line. In the case of the majority of the examined stations the maximal standard deviations appear during the months of winter, while the minimals during the months of the summer season, similarly to the yearly line of monthly mean temperatures [1]. The basical feature characterising the structure of pressure standard deviation on the Earth may be established in the fact that it increases from the tropical territories to the polar area. The latitude-wise alteration is quite significant, at subpolar latitudes the standard deviation of monthly mean values of pressure is 4—7 times as much as experienced near the equator. The characteristical structure is illustrated by *Fig. 1*, where the mean values of standard deviation in February and in August are recorded.

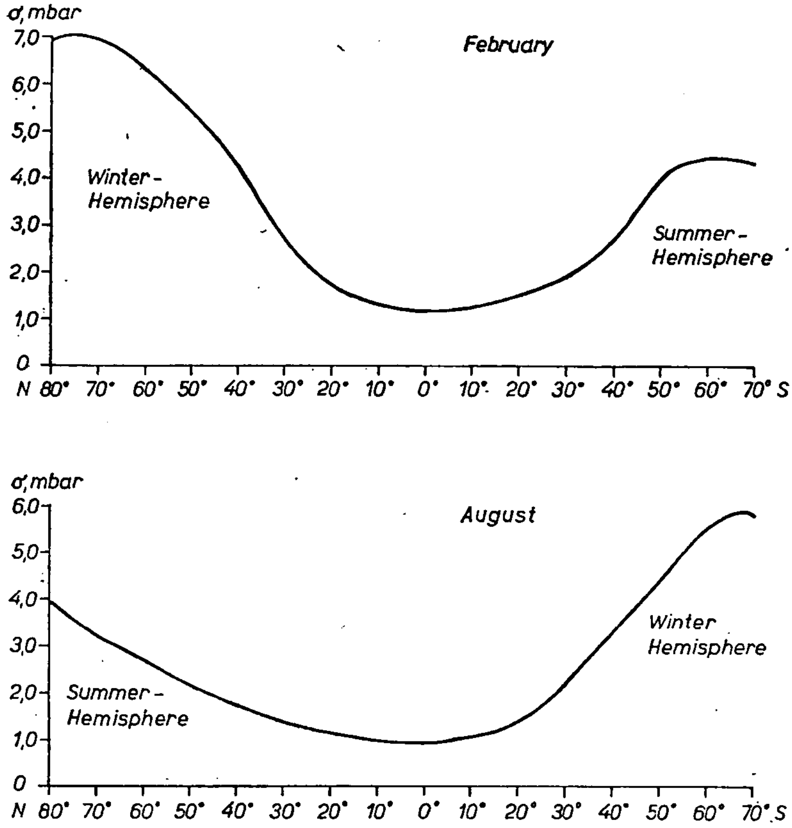

Fig. 1. Standard deviation of monthly mean pressures as a function of latitude

In a predominant territory of the northern hemisphere maximal standard deviation was experienced in December, in January or in February while on the southern hemisphere in July or in August, that is it appears during the winther season. On the other hand no uniformal date may be indicated as to when the appearence of maximal standard deviation may be expected on the tropical territories (approximatively between 20° north latitude and 10° south latitude *(Fig. 2)*.

On the medium and higher latitudes of the northern hemisphere the minimal standard deviation appears very characteristically, during the summer months (June—July—August) while on the southern hemisphere it is shifted rather to the end of summer (February) and principally to the beginning of autumn (March) *(Fig. 3)*.

The territorial structure of the monthly mean values of pressure standard deviation is illustrated by the maps of distribution of values in February and in August (*Fig 4 and 5*). During the winter of the northern hemisphere (February) the greatest

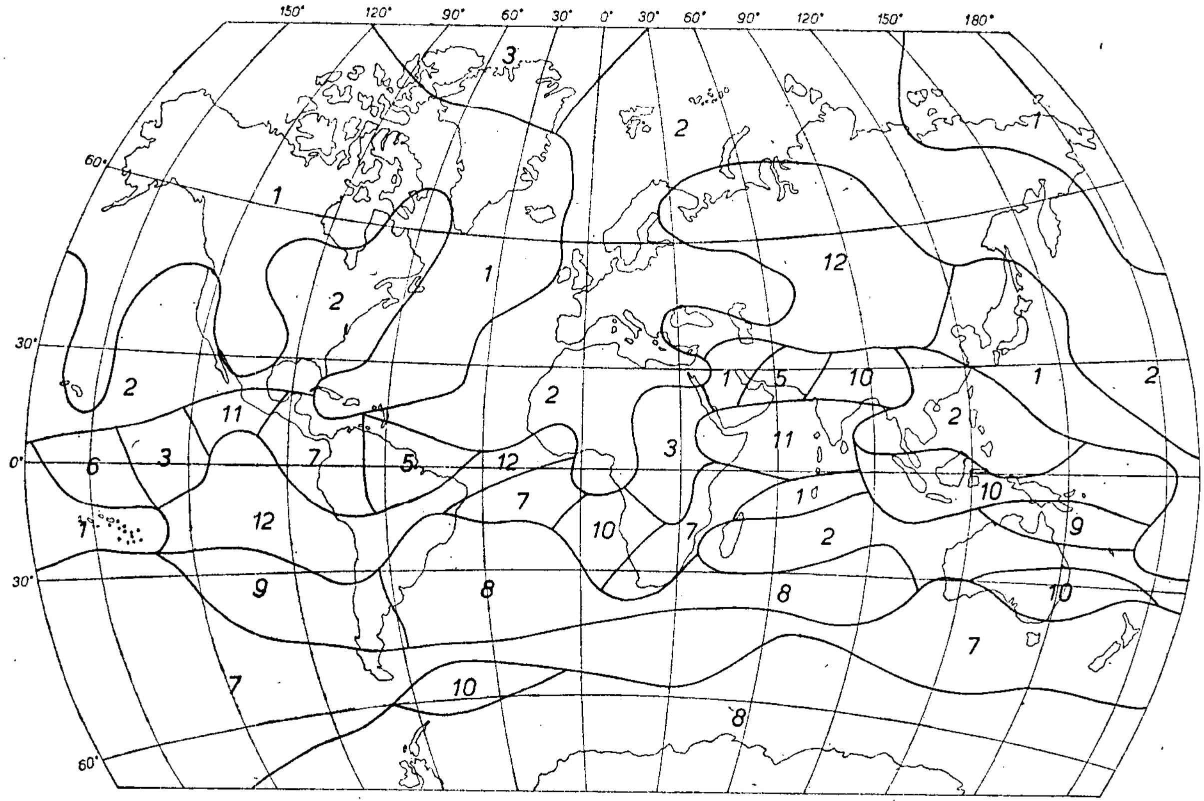

Fig. 2. The month of maximal standard deviation of pressure

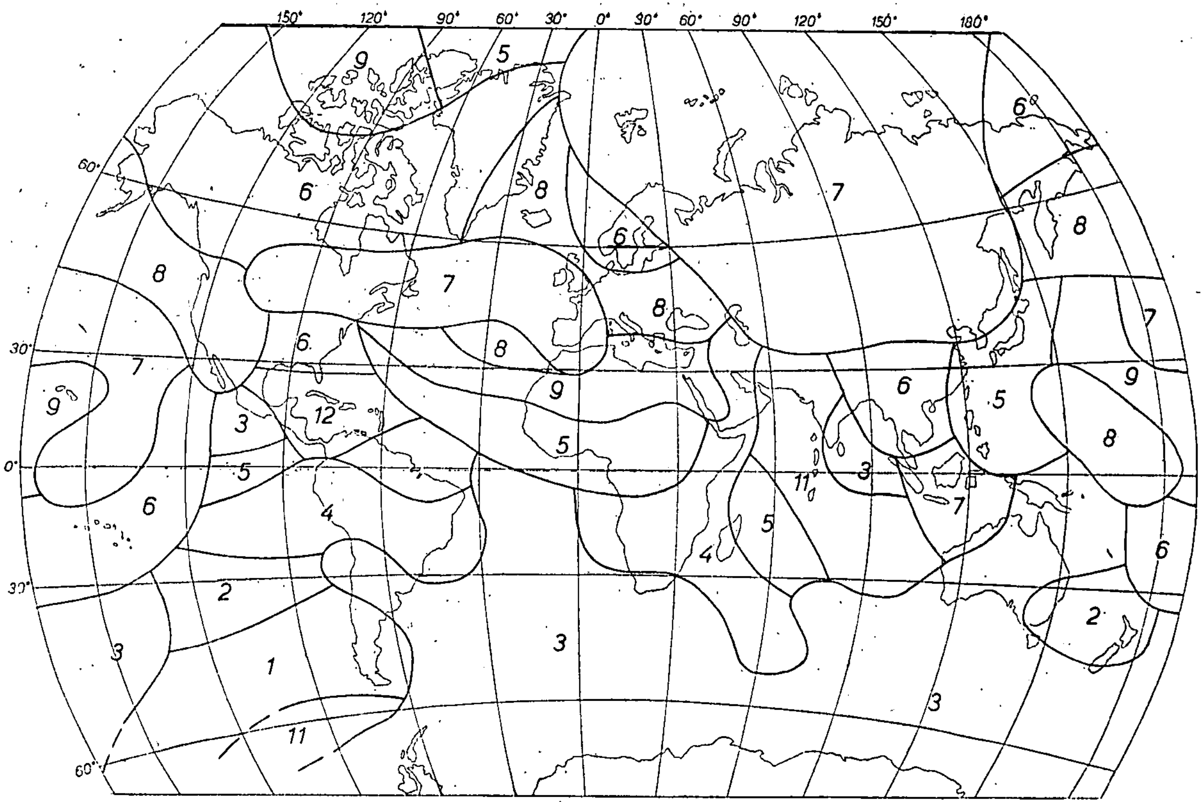

Fig. 3. The month of minimal standard deviation of pressure

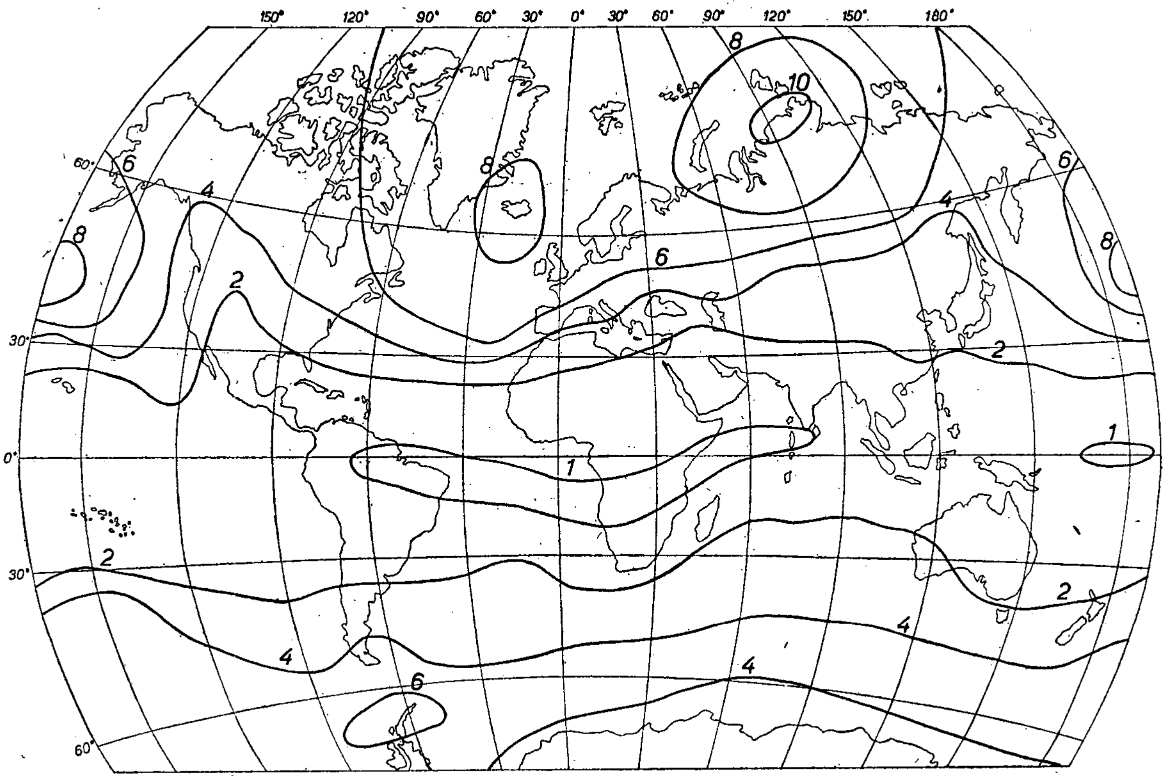

Fig. 4. Standard deviation of pressure in February

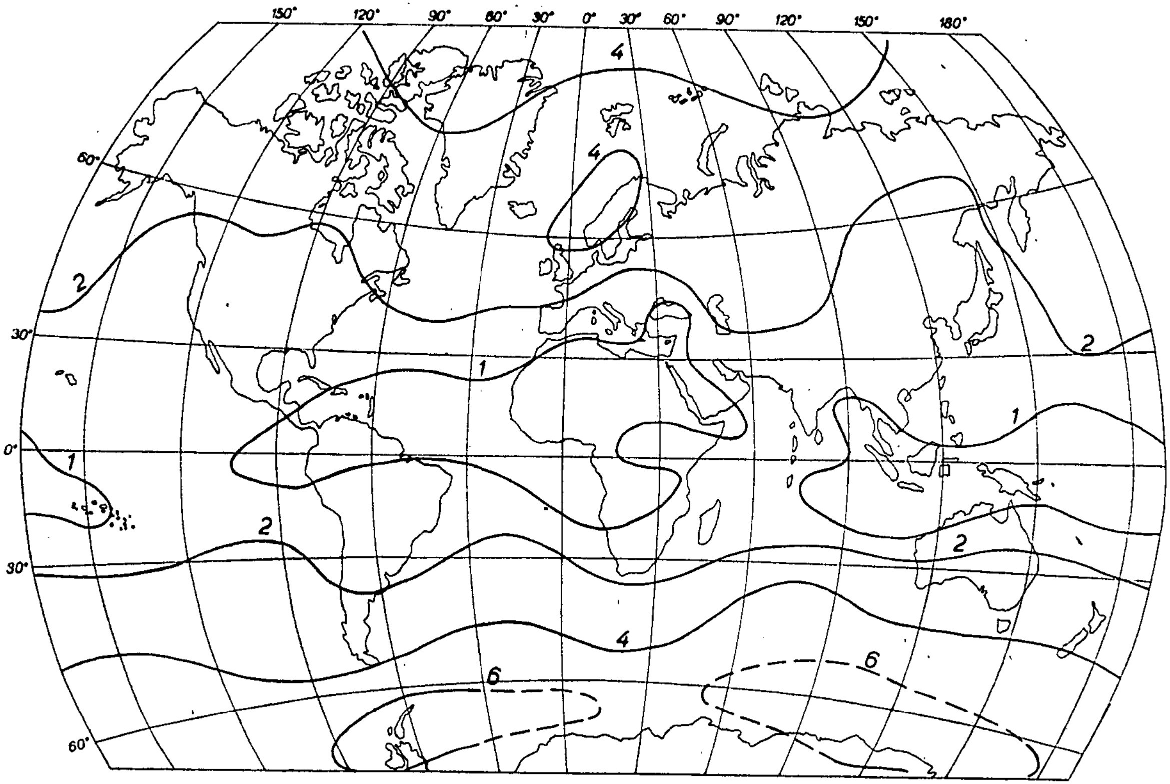

Fig. 5. Standard deviation of pressure in August

Table 1

Standard deviation of monthly sea level pressure averages (mbar)

Stations	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1. Alert	7,3	6,5	7,5	3,6	2,7	3,7	3,7	4,6	3,2	3,7	4,2	4,3
2. Barrow	5,2	5,1	3,5	3,5	3,1	2,2	2,8	2,5	3,1	3,4	4,5	5,1
3. Mould Bay	6,2	5,5	5,7	3,5	2,8	3,3	3,8	3,7	2,5	3,6	3,4	3,9
4. Isfjord Radio	6,3	6,9	6,5	4,0	3,4	3,5	3,0	3,6	4,0	5,7	5,5	5,7
5. Chelyuskin	8,4	10,4	8,6	5,9	4,3	3,4	2,8	4,2	4,8	4,8	7,2	5,8
6. Wrangel	5,5	5,0	4,0	4,0	2,7	2,0	2,3	2,7	3,7	3,8	5,2	4,6
7. Fort Simpson	4,8	4,6	4,0	3,7	2,9	2,3	2,4	2,6	2,6	3,7	3,8	4,6
8. Resolution Island	5,9	6,2	5,2	2,8	2,8	2,4	2,9	2,6	3,1	3,3	3,3	4,0
9. Stykkisholmur	9,9	8,2	7,7	4,3	5,5	3,9	3,6	3,5	4,5	6,0	6,9	7,4
10. Bergen	6,8	7,3	6,1	4,3	3,0	2,5	4,0	4,6	4,5	5,0	6,4	6,2
11. Arkhangelsk	7,9	7,6	7,3	3,5	3,3	2,6	2,4	3,5	4,1	5,9	8,0	8,5
12. Turukhansk	7,0	9,0	5,8	4,1	2,4	2,4	1,9	3,0	3,7	3,5	7,3	8,3
13. Yakutsk	4,5	6,4	3,6	2,3	2,0	1,9	1,4	1,9	2,4	2,7	4,2	5,4
14. St. Paul	9,1	6,8	4,4	4,6	4,4	3,3	2,6	2,1	3,6	2,8	7,2	7,7
15. Yakutat	6,5	4,0	5,0	3,5	2,1	2,2	2,3	2,4	3,4	4,8	4,7	5,2
16. Churchill	4,6	4,6	3,4	2,5	2,3	1,7	1,8	2,1	2,8	2,3	3,0	2,9
17. Irkutsk	3,4	4,7	3,3	2,5	1,6	1,8	1,4	1,8	2,3	2,1	3,6	5,1
18. Petropavlovsk	4,5	4,7	4,5	3,5	4,0	2,2	2,3	2,1	3,5	3,3	4,1	3,7
19. Eureka	3,4	4,0	2,9	2,1	1,6	1,2	1,6	1,1	1,3	1,3	2,8	2,9
20. Winnipeg	3,7	3,9	2,8	1,8	1,9	1,6	1,3	1,6	1,5	2,2	1,6	2,6
21. Ship Station D.	7,4	7,2	5,9	4,8	4,3	3,3	2,0	2,0	2,2	2,7	4,5	5,5
22. Brest	6,2	7,8	5,9	4,0	2,5	2,6	1,8	2,5	2,9	5,1	5,7	6,5
23. Budapest	4,3	5,6	3,9	2,3	1,7	2,1	1,7	1,7	1,9	3,7	4,1	5,2
24. Samsun	2,9	3,4	2,6	1,6	1,8	1,8	0,9	0,6	1,1	1,9	2,2	3,4
25. Guryev	4,7	4,8	4,0	2,5	1,5	1,7	1,4	2,2	1,8	2,3	4,6	4,0
26. Balkhash	3,4	3,6	3,1	2,1	2,1	1,7	1,5	2,5	2,1	1,6	3,4	3,9
27. Vladivostok	3,1	2,7	2,4	2,6	1,7	1,8	1,6	1,7	1,7	2,0	2,6	2,9
28. $\varphi=40°$ N, $\lambda=170$ W	6,8	8,2	4,9	3,3	2,1	2,9	2,0	2,2	2,7	3,4	4,3	5,8
29. Ship Station N.	3,9	3,1	3,1	1,9	2,1	1,5	1,2	1,4	1,7	1,9	2,1	3,0
30. El Paso	2,2	1,8	1,3	1,6	1,3	1,4	1,4	1,1	1,3	1,6	1,5	1,7
31. Charleston	1,8	2,6	2,0	2,1	1,9	1,3	1,4	1,4	0,7	1,7	1,4	1,5
32. Ship Station E.	5,2	4,7	4,8	3,0	2,6	3,2	1,9	1,8	1,5	1,7	2,6	3,5
33. Ponta Delgada	6,1	6,4	4,8	3,7	2,6	2,2	1,8	1,6	2,1	2,3	3,2	4,3
34. Oran	2,9	3,6	3,4	1,7	1,4	1,0	0,9	1,0	1,2	2,2	2,6	3,0
35. Luga	2,8	3,9	3,1	2,1	1,9	1,4	1,1	1,2	1,0	2,4	2,4	3,3
36. Alexandria	1,4	1,9	1,8	1,7	1,7	1,2	0,9	0,9	0,8	1,4	1,3	1,0
37. Bagdad	1,8	1,5	1,1	0,7	0,7	1,2	1,3	1,4	1,3	0,9	1,1	1,6
38. Tokyo	2,8	2,2	1,8	1,9	1,1	1,3	1,2	1,6	1,4	1,5	1,4	2,0
39. Ship Station V.	4,0	4,0	3,1	2,3	1,9	1,8	1,6	2,0	1,3	1,5	2,0	3,3
40. Honolulu	2,1	1,6	1,9	1,8	1,0	1,0	1,0	1,1	0,9	1,0	1,5	1,3
41. Tessalit	1,3	1,6	1,5	0,9	1,0	0,9	1,0	0,9	0,8	1,0	1,3	1,2
42. Karache	1,2	1,3	1,3	1,2	1,5	1,3	1,4	1,1	1,4	1,4	0,9	1,0
43. Dibrugarh	1,5	1,5	1,5	1,2	1,0	0,9	1,5	1,3	1,3	1,7	1,4	1,5
44. Taipei	1,7	1,8	1,4	1,0	0,8	1,0	1,5	1,8	1,6	1,4	1,5	1,2
45. Marcus Island	2,1	1,7	1,5	1,4	1,3	1,2	1,1	1,1	1,3	1,3	1,2	1,3
46. Acapulco	1,5	1,5	1,1	1,2	1,3	1,2	1,3	1,1	1,2	1,5	1,6	1,6
47. San Juan	1,8	1,2	1,1	0,9	0,8	0,8	0,9	0,8	0,8	0,9	0,8	0,7
48. Sao Vincente	1,3	1,4	0,9	0,9	0,5	0,7	0,9	0,8	0,9	0,8	0,6	1,1
49. El Fasher	1,5	1,4	1,5	1,3	1,1	0,8	1,0	0,9	0,9	1,1	0,8	1,5
50. Djibouti	1,6	1,3	0,9	1,2	1,5	1,1	1,1	0,6	1,4	0,8	1,7	1,0
51. Port Blair	1,1	1,3	0,7	1,1	0,8	0,5	1,0	0,7	0,7	1,0	1,3	1,2
52. Fanning Island	1,0	1,1	1,1	1,1	1,3	1,6	1,0	1,2	1,2	1,2	1,2	1,2
53. $\varphi=0°$, $\lambda=120°$ W	1,7	1,7	2,5	1,6	1,3	1,1	1,6	1,3	1,7	1,5	1,6	1,6
54. Freetown	1,3	1,3	0,7	0,8	0,5	0,7	0,7	0,6	0,7	0,7	1,0	1,3
55. Sao Tome	0,7	1,2	0,9	0,9	0,6	0,9	0,8	0,9	0,8	1,0	0,6	1,0
56. Kishangani	0,9	1,2	1,6	1,3	0,8	1,3	1,1	1,3	1,3	1,2	1,2	0,9
57. Colombo	1,0	1,0	0,6	0,7	1,1	0,9	1,0	1,1	0,8	0,8	1,2	1,1
58. Pontianak	1,2	1,1	1,0	0,8	0,7	0,9	0,6	0,8	1,0	1,3	0,8	1,1
59. Koror	1,2	1,5	1,0	0,9	0,7	1,0	1,0	0,1	0,9	0,9	1,0	1,0

Stations	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
60. Tarawa	0,8	1,0	0,8	0,9	0,9	0,9	1,0	0,7	1,1	1,1	0,8	0,8
61. $\varphi=2°$ S, $\lambda=107°$ W	1,3	1,4	1,1	1,0	0,7	1,5	1,4	1,0	1,0	0,9	1,1	2,0
62. Guayaquil	0,8	1,1	1,0	0,6	1,0	1,0	1,3	0,9	1,2	1,0	1,1	1,2
63. Turiacu	1,1	0,9	1,0	1,1	1,2	1,0	1,2	1,0	1,0	1,0	1,2	1,1
64. Ascension Island	0,7	0,9	0,7	0,8	0,7	1,0	1,3	1,0	1,1	1,0	0,7	0,6
65. Mombasa	0,8	0,9	0,8	0,7	0,9	0,9	1,1	1,0	0,8	1,0	0,9	1,1
66. Diego Garcia	1,9	1,5	1,2	1,0	1,1	1,5	1,2	1,0	1,1	0,9	1,3	1,4
67. Port Moresby	1,0	1,1	0,7	0,8	1,1	0,9	0,9	1,0	1,2	1,0	1,1	1,1
68. Apia	1,5	1,3	0,9	0,8	0,7	0,6	0,8	0,8	0,8	0,7	0,9	0,9
69. Papeete	1,4	1,3	1,2	0,9	0,8	0,8	1,0	1,0	1,1	0,9	0,9	1,1
70. $\varphi=13°$ S, $\lambda=107°$ W	1,0	1,2	1,0	0,7	1,1	1,4	1,5	1,3	1,3	1,2	1,0	1,6
71. Mocamedes	0,9	0,9	0,9	0,9	1,0	1,0	1,2	0,9	1,1	1,3	1,1	1,0
72. Plaisance	1,6	2,0	1,6	1,0	0,9	1,5	1,1	1,1	1,0	1,3	1,1	1,2
73. Broome	1,8	1,9	1,6	1,4	1,7	1,3	1,3	1,0	1,4	1,4	1,5	1,5
74. Antofagasta	1,6	1,6	1,2	1,3	1,4	1,3	1,6	1,3	1,4	1,6	1,1	1,7
75. Rio de Janeiro	1,1	1,2	1,2	0,7	1,3	1,3	1,2	1,6	1,3	0,8	0,9	1,5
76. $\varphi=30°$ S,$\lambda=100°$ W	2,0	1,7	1,8	1,7	2,4	1,9	1,6	2,5	2,5	2,1	1,7	2,3
77. $\varphi=30°$ S,$\lambda=10°$ W	2,0	2,0	1,8	1,9	1,9	2,3	1,9	2,6	2,3	2,0	1,9	2,3
78. $\varphi=30°$ S,$\lambda=90°$ E	2,1	2,2	1,7	1,5	1,8	1,8	2,0	2,8	2,1	1,7	1,4	2,3
79. Tristan da Cunha	2,4	1,9	1,8	2,1	2,2	2,8	2,5	3,3	2,3	2,2	2,3	2,7
80. Cape Town	1,0	1,4	0,8	1,0	1,5	1,9	1,4	1,6	1,3	1,4	1,1	0,9
81. Ile Nouvelle Amsterdam	2,7	2,9	2,1	2,2	2,8	2,9	3,3	4,3	3,8	2,9	3,3	2,9
82. Perth	1,7	2,1	1,0	1,6	2,7	2,4	2,8	2,4	1,8	1,4	1,2	1,2
83. Sydney	2,3	1,4	1,5	2,7	3,3	3,3	3,0	2,7	2,2	3,3	2,3	2,4
84. Auckland	3,3	2,0	2,2	3,5	2,8	3,8	4,7	3,4	3,7	4,0	4,2	3,2
85. $\varphi=40°$ S,$\lambda=160°$ W	4,5	4,5	2,5	3,4	3,7	3,2	5,4	3,5	3,1	3,4	3,3	4,1
86. Trelew	1,6	2,3	1,9	2,5	2,3	2,3	2,2	2,3	2,4	2,0	2,4	2,5
87. Marion Island	3,1	3,7	2,6	3,2	2,8	4,4	4,5	3,4	3,1	3,7	4,1	3,1
88. Kerguelen	4,4	4,3	4,4	3,0	3,6	3,9	4,4	5,4	4,2	3,3	4,4	4,2
89. Punta Arenas	2,6	4,3	3,8	4,2	3,2	4,0	4,6	3,6	4,1	3,7	2,6	3,3
90. Grytviken	3,6	3,6	2,7	4,3	4,7	3,6	4,2	4,2	4,3	5,3	4,8	3,6
91. Macquarie Island	5,2	4,1	3,4	3,8	4,2	4,8	4,9	5,2	4,0	4,2	4,6	4,1
92. $\varphi=60°$ S,$\lambda=160°$ W	3,7	4,6	5,1	5,3	4,4	4,5	7,0	4,8	4,0	4,7	4,2	3,8
93. $\varphi=60°$ S,$\lambda=90°$ W	3,8	4,2	3,3	4,3	5,3	3,7	5,5	4,1	4,9	4,6	3,0	5,2
94. Argentina Island	4,0	6,2	4,5	4,4	5,3	5,3	5,2	6,7	5,1	4,4	5,8	4,5
95. $\varphi=70°$ S,$\lambda=40°$ E	4,0	3,5	3,0	3,1	3,4	4,4	4,9	5,1	3,3	3,2	3,1	4,9
96. $\varphi=70°$ S,$\lambda=120°$ E	4,6	3,5	3,1	3,5	3,9	5,2	4,4	6,5	5,3	3,5	4,0	4,8

standard deviation values>8 mbar are found on the northern edge of Asia in the territory of Cape Chelyuskin as well as in the territory of North Atlantic and North Pacific subpolar centres of influence with low pressure (Iceland, Aleut Isles). On the other hand in the zone of the equator the standard deviation occurs with less than 1,5 mbar values everywhere. During the winter of the southern hempisphere (August) maximal standard deviation >6 mbar values appear in the oceanic territories north from the Antarctic, in the subpolar regions of the southern hemisphere. Relatively small standard deviation values can be found on the territory of centres of influence with low pressure in the northern hemisphere. Comparing the two maps it can be seen, that the area of minimal standard deviation well coincides with the position of intertropical convergency zone, stretching slightly southward from the equator during the summer of the northern hemisphere and streching mostly northward from the equator during the summer of the northern hemisphere.

Finally it may be concluded that on the Earth the temporal variability of pressure field appears to be the greatest in the areas of subpolar low pressures during winter while it is the smallest in the territories of intertropical convergency zones.

Reference

Péczely, G.: Variability of Monthly and Annual Mean Temperatures on the Earth Időjárás *78* (1974), 202—209.

A METHOD OF ANALYSING MACROSYNOPTIC TYPES USING ANALOGY INDICES

by

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A makroszinoptikus típusok analízise analógia index segítségével. A tanulmány azt elemzi, hogy a szinoptikus módszerekkel makroszinoptikus típusba sorolt nyomásmezők milyen kapcsolatban állanak a különböző típusokhoz tartozó átlagos nyomásmezőkkel. A vizsgálatban az analóg indexet és az objektumok összetartozásának számszerű jellemzésére szolgáló mérőszámot alkalmazzák.

In the paper ware examined the analogy between individual pressure fields classified into macrosynoptic types by synoptic methods and the mean pressure fields of the different types. By examinations was used the analogy index and the measure for the numerical characterization of the relatedness of the objects.

The relation between the macrosynoptic types used in meteorology and the analogy indices was discussed in our earlier papers. The mathematical definition of the analogy index was formulated, and some problems of principle of the forecasting by using analogies (including the accuracy of forecasts) were analysed in [1] and [2]. The typifyng of meteorological objects with the aid of analogy indexes was the subject of [3]. We considered, among others, the degree of analogy that can be formed between the mean fields of different macrosynoptic types, in other words, how "far" these mean fields are situated from each other. In continuation of these studies, we shall examine in the present paper the analogy between the individual fields classified into macrosynoptic types by synoptic methods and the mean fields of the different types. In the light of the results, conclusions may be drawn regarding the practical uncertainties of the synoptic classifications and about the practicability of typifying by computer methods.

The description of the complicated meteorological (synoptic) situations necessitates the use of a great number of parameters. With a view to simplifying the model, the situations are, therefore, grouped into classes (groups, clusters), corresponding to the above mentioned macrosynoptic types. Each class is denoted by an appropriate codefigure called macrosynoptic code. The characteristics of the various classes are chosen in such a manner that all the situations belonging to one given class (i. e. having the same code) have similar properties, while any two situations belonging to different classes are distinquishable on the basis of their different properties.

Many macrosynoptic code systems have been developed, which differ from each other in the area covered, in the atmospheric elements selected for the meteorological model and in the purpose of application. (It is evident that there can be no "universal" typifying system meeting the most general conditions.) The most widely used classification in Europe is the *Hess—Brezowsky* type-system, comprising 29 macrosynoptic types [4]. Most countries use their own special macrosynoptic code systems, and many countries apply more than one, such system. The macrosynoptic classification system developed by *Péczely* for use in Hungary contains 13 types of situation ς]]. The *Péczely*-codes have been determined and are published in [6] for each day from 1877 till practically today. It may be mentioned that other specialpurpose code systems have also been elaborated for Hungary. For example, *B. Bőjti* established a system applicable in meteorological research relating to the Lake Balaton region; *E. Jakus (Mrs. I. Bodolai)* elaborated another code system for the purpose of precipitation forecasting.

For the classification of the meteorological situations by computer, it is necessary to prepare an adequate, unequivocally defined, correct mathematical model. This model, necessary to the formation of types, should include the following:

(a) A clear description of the system of parameters (atmospheric elements, co-ordinates, dimensions, etc.) used for characterizing the object considered;
(b) The analogy index, which is the measure used for the comparison of the objects;
(c) The definition of the measure used for the numerical characterization of the relatedness of the objects.

(a) The method of description of the objects to be classified

In the investigations we used grid-point values of the 500 mb geopotential field (AT_{500}). The area covered and the grid network are shown in *Fig. 1*. The analysis refers to the 4018-day period from 1 January 1956 to 31 December 1966.

Let

$$\underline{\xi} = (\xi_1, \xi_2, \ldots, \xi_i, \ldots, \xi_{80})$$

denote the AT_{500} values, interpreted as probability variable at the grid points, and Θ the macrosynoptic code for the same time. Accordingly, the value (or realization) of the probability vector variable for one day (the j-th day) of the time period examined will be denoted by

$$\underline{X}_j = (X_{j1}, X_{j2}, \ldots, X_{ji}, \ldots, X_{j80})$$

and the *Péczely* macrosynoptic code for the same day by ϑ_j. The AT_{500} grid point values for the ϑ_j-th day are determined by interpolation from the tables of the Deutscher Wetterdienst and are stored on a special magnetic tape, while the macrosynoptic codes relating to the same time are contained in [6]. The macrosynoptic types have been coded in figures as follows:

1	2	3	4	5	6	7	8	9	10	11	12	13
mCc	AB	CMc	mCw	Ae	CMw	zC	AW	As	An	AF	A	C

The full observational material is thus comprised by (1) the $\underline{\underline{X}}$ matrix formed by the realizations of $\underline{\xi}$, and (2) the $\underline{\vartheta}$ vector representing the realizations of Θ:

$$\underline{\underline{X}} = \begin{pmatrix} x_{11} & x_{12} & \cdots & x_{1N} \\ x_{21} & x_{22} & \cdots & x_{2N} \\ \vdots & & & \vdots \\ x_{n1} & x_{n2} & \cdots & x_{nN} \end{pmatrix} \qquad \underline{\vartheta} = \begin{pmatrix} \vartheta_1 \\ \vartheta_2 \\ \vdots \\ \vartheta_n \end{pmatrix}$$

$$N = 80, \quad n = 4018$$

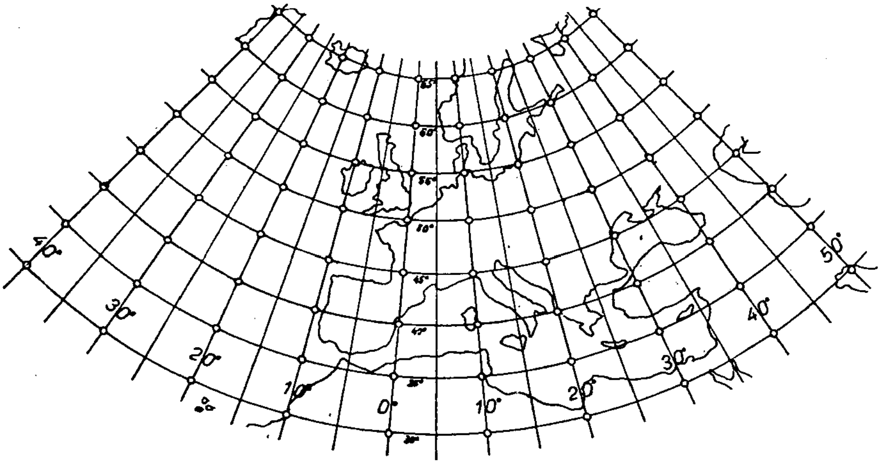

Fig. 1. The area covered and the grid system used

(b) The analogy index

The objects to be classified may be described by points of the N-dimensional space. In order to ensure that, when forming the classes, the points representing similar objects belong to the same class and the points corresponding to objects differing from the earlier ones belong to other classes, it is necessary to define some numerical criterion for the measurement of similarity. Analogy means relationship between two objects considered, it is also called their similarity or their association capability relating to each other. The analogy index is the measure expressing the similarity of two objects in numerical form. This index is an important element of the classification procedure, since it represents the condition of classifying two objects into the same class or into different classes.

Let us consider now, in general, two vectors in the N-dimensional field:

$$\underline{x} = (x_1, x_2, \ldots, x_N),$$

$$\underline{y} = (y_1, y_2, \ldots, y_N).$$

Any $\varrho(\underline{x}, \underline{y})$ function interpretered for the $\underline{x}, \underline{y}$ pair of vectors is called analogy index if it satisfies the following cosditions:

1. $\varrho(\underline{x}, \underline{x}) = 1$ for any $\underline{x}$,
2. $\varrho(\underline{x}, \underline{y}) = \varrho(\underline{y}, \underline{x})$ for any $\underline{x}, \underline{y}$.
3. The $\Delta(\underline{x}, \underline{y}) = 1 - \varrho(\underline{x}, \underline{y})$

function satisfies the so-called triangle inequality, i.e. for any $\underline{x}, \underline{y}, \underline{z}$

$$\varrho(\underline{x}, \underline{y}) \geqq \varrho(\underline{x}, \underline{z}) + \varrho(\underline{z}, \underline{y}) - 1.$$

From these conditions it follows that the analogy index meets the following inequality:

$$0 \leqq \varrho(\underline{x}, \underline{y}) \leqq 1.$$

The analogy of two objects $\underline{x}, \underline{y}$ is defined as the values of their analogy index $\varrho(\underline{x}, \underline{y})$

(In some cases the fulfilment of the triangle inequality is dispensed with.)

In our investigations we used the analogy index derived from the *Euclidean* metric:

$$\varrho(\underline{x}, \underline{y}) = \varrho_E(\underline{x}, \underline{y}) = \frac{1}{1+\sqrt{\sum_{i=1}^{N}(x_i-y_i)^2}}.$$

We performed the calculations also for several other analogy indices, manuely for the *Bagrovean* index and a number of its modified versions, but the results obtained for $\varrho_E(\underline{x}, \underline{y})$ only are discussed here.

(c) The criterion of class formation

For checking the optimization of the grouping, we applied the procedure known as centroid method, which is used in from recognition and cluster analysis.

To this end, the mean AT_{500} fields of the days having the same macrosynoptic code have been calculated on the basis of the data the 4018 days considered. The mean field of the days with the i-th macrosynoptic type is denoted by

$$\underline{\eta}^i = (\eta_1^i, \eta_2^i, \ldots, \eta_N^i) \qquad i = 1, 2, \ldots, L$$

The $\underline{\eta}^1, \underline{\eta}^2, \ldots, \underline{\eta}^L$ type mean fields may also be represented in the 80-dimensiona field corresponding to the number of the grid points. Since the *Péczely* macrosynopitc codes were used in our study, L=13.

We examined, in particular, to what extent the L=13 mean fields resembled the corresponding pictures which served as a basis for the definition of the types and which are published in [5]. Our analysis showed that there were no significant differences, and the averaging procedure even led to the statistical levelling of certain errors. One of the mean fields is shown in *Fig. 2,* for the others reference is made to [8].

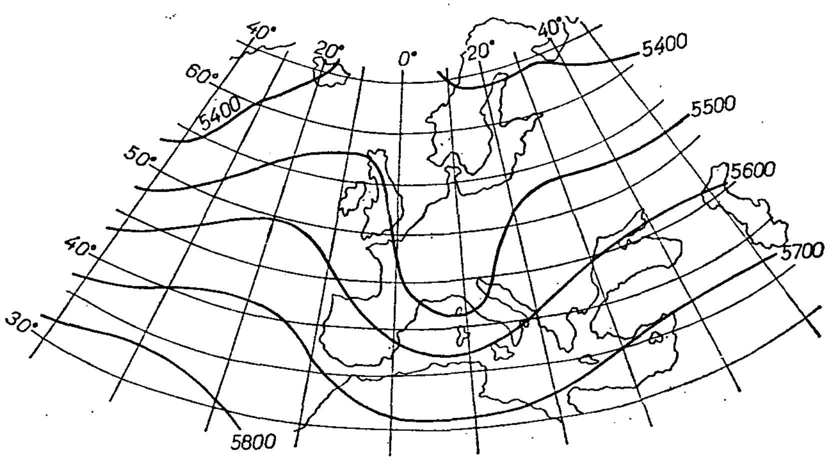

Fig. 2. The mean field of the CMw types (No. 6 in the Péczely classification)

These type means may be interpreted as the fields which are most characteristic of their respective types, etalons of the classes represented by them. It may, therefore be expected that if the AT_{500} fields of the individual days are represented by points of, the 80-dimensional field, then these points will be situated, in the form of clouds of points, around the points corresponding to the type mean fields, and that these clouds will be far from each other. The picture will thus be similar to that of the galaxies in the space. Such a distribution of prints, considered as optimal, is represented in *Fig. 3*.

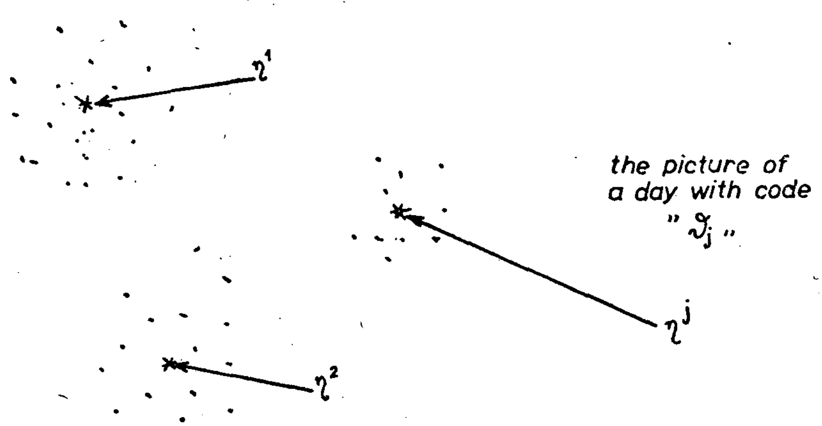

Fig. 3. Two-dimensional representation of the expected distribution of the mean fields and of the individual days

In reality the situation will not, of course, be so nice. The expected ideal distribution may be distored by a number of error sources, e.g. errors made in the course of the classifications, the selection of the analogy index, the fact that inour study we considered only the AT_{500} field, etc.

In the investigations described below, the field data of 46ｉ days were used. The *Euclidean* analogy indexes were determined for each individual day ($\underline{x}_j=(x_{j1}, x_{j2}, \ldots \ldots x_{jN})$, $j=1, 2,\ldots,465$) and for each type mean (etalon) field $\underline{\eta}^i$, $i=i=1,2,\ldots 13$. As shown above, the analogy between the mean of the i-th type and the day with index j is

$$\varrho_E (\underline{\eta}^i, \underline{x}_j)= \frac{L}{1+\sqrt{\sum_{k=i}^{80} \eta_k^i - x_{jk})^2}}$$

For each $\varrho_E(\underline{\eta}^i \underline{x}_j)$ of the days considered, the values ($i=1,2,\ldots,13$) were then arranged in order of magnitude, and the corresponding code numbers were recorded. In other words, the first place in the resulting series was occupied by the code number of the type showing the greatest analogy with the field of the given day, while the last figure in the series was the code number of the type with the least analogy. This classification, obtained by the application of the *Euclidean* metric, was then compared with the ϑ_j synoptic type of the day in question. For each of the 465 days, we have calculated and recorded the serial number (place) of the *Péczely* code of the day as determined by the synoptician, in the above series of code numbers.

The results are summarized in *Table 1*. By way of explanation the meaning of the line marked by an asteriste in *Table 1* includes the following:

According to the classification made by the synoptician, the *CMw* type (No. 6) occurred 16 times out of the 465 examined cases; in our classification (using *Euclidean* analogy indexes) this same type ranked 4 times first and 5 times second (out of the 16 cases).

Table 1

Frequency of occurence of the serial numbers of classification of the Péczely codes (based on a sample of 465 days)

Péczely code	Serial number of classification 1	2	3	4	5	6	7	8	9	10	11	12	13
1	1	3	—	3	—	—	6	1	3	—	—	1	—
2	6	6	2	6	1	4	3	1	1	2	1	3	1
3	8	1	—	—	—	—	—	—	—	4	1	—	—
4	7	13	4	3	2	—	—	—	1	3	—	—	—
5	4	12	4	8	3	10	1	3	1	—	1	1	—
6	4	5	4	1	—	—	1	—	—	1	—	—	—
7	2	3	6	4	3	2	—	—	2	—	—	—	—
8	25	10	8	4	2	5	2	3	2	2	10	4	2
9	27	1	—	—	—	—	1	—	—	1	1	1	—
10	—	8	2	9	8	4	4	5	3	3	1	—	—
11	18	12	6	2	1	4	—	1	1	—	—	1	—
12	11	7	11	10	9	11	3	3	1	2	—	—	—
13	—	—	1	2	1	—	1	—	—	—	—	—	—

The analysis of the table shows that:

(a) The code determined by the synoptician (here in after called "proper code") is in surprisingly good agreement with the code determined on the basis of the AT_{500} field with the aid of the analogy derived from the *Euclidean* metric. (This latter code might be referred to as "machine code"). The index of the most analogous mean field is identical with the proper code in 25 per cent of the cases.

(b) In certain cases, for example for the types Nos. 4, 6, 9, 11, the ϑ_j proper code is in particularly conspiciuous agreement with the most analogous mean field.

(c) There is, however, a strikingly great disagreement in the case of codes Nos. 8 and 10. There may be a number of reasons for this, for example, these types may not be well distinguishable in the AT_{500} field, the analogy index we have chosen may not be suitable for distinguishing them, and the ϑ_j "proper code" may also be erroneous.

A detailed discussion of the data in *Table 1* for each individual type is not given here. The information contained in the Table is, however, represented in condensed form in *Fig. 4*. The graph shows the frequency of occurrence of the *Péczely* ("proper") code of the fields in the lst, 2nd, 3rd,...13th places.

The figure indicates, for example, that during the 465 day period there were 81 days for which, among the codes ranked on the basis of the *Euclidean* analogy indexes, the "proper code" of the day as determined by the synopticians occupied the 2nd place.

Fig. 4 shows also that in 25% of the cases the proper code of the day appears on the lst place, which means that in these cases the *Euclidean* analogy classification fully coincided with the "synoptic" classification.

It is in 42 per cent of the total number of days that the synoptic "proper code" of the day stands on the lst or the 2nd place.

It is only 20 per cent of the cases of the 465 day sample that the "proper code" was ranked by the program to a place with serial number 6 or greater. This result may be regarded as very favourable.

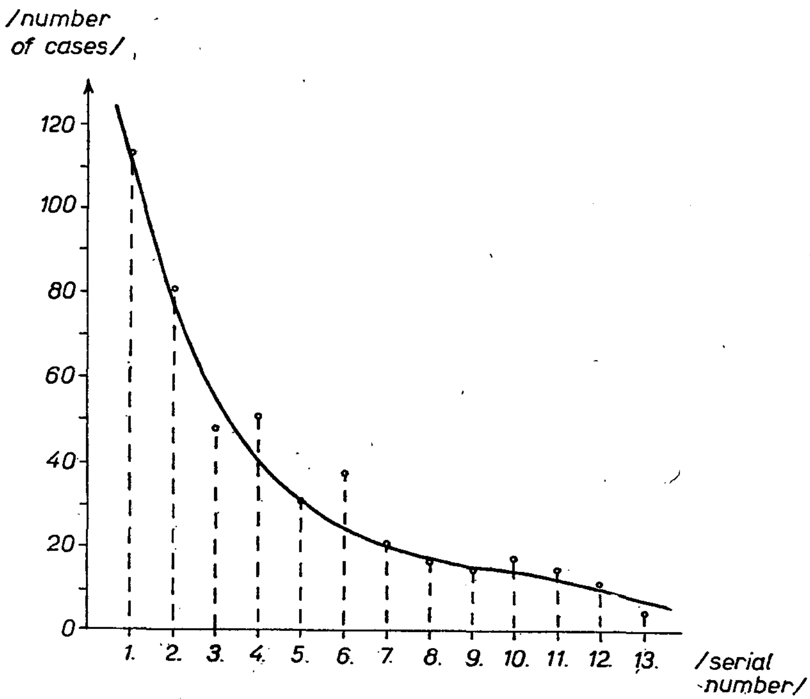

Fig. 4. Frequency of occurence according to the serial number of the proper code (in the classification using Euclidean analogy indexes)

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LARGE SCALE WEATHER SITUATIONS IN HUNGARY AND THE PERIODICAL COMPONENTS OF THEIR TIME ARRAY

by

L. Makra

Magyarország makroszinoptikus helyzetei idősorának periodikus összetevői. Dolgozatunkban azon kérdésekre kívántunk választ kapni, hogy a Magyarország éghajlatát meghatározó légköri folyamatok időbeli menetében kimutathatók-e ritmikus változások; a légköri folyamatok hogyan kapcsolódnak a mérsékelt öv atlanti-óceáni térségének áramlási rendszeréhez, valamint arra, hogy milyen összefüggesek rejlenek az északi félteke atlanti-óceáni ill. csendes-óceáni hatásközpontjai között.

In present work it was tried to find the answer if there could be detected a rhytmical alteration in the chronologic line of atmospherical processes determining the climate of Hungary; how these atmospherical processes connect to the circulation system of the Atlantic territory of the temperate zone and what kind of relations can be detected between the Atlantic and Pacific centres of influence of the northern hemisphere.

The rhytms of large scale weather situations in Hungary

In the first part of the present work it was examined if there were alterations meaning periodicity in the time arrays of large scale weather situations which determine the circulation above the Carpathian Basin and were characteristic of Hungary. The basic material for this analysis was constituted by the frequency time array of 100 years between 1877 and 1976, based on the catalogue [4] of large scale weather situations established for Hungary. The yearly, winter and summer halfyear frequencies of individual large scale weather situations were established for each day of that period while the frequency values of large scale weather situations which can be corresponded to the main circulation phases served as the basis of analysis *(Table 1, 2, 3)*.

As a preliminary the main circulation types in the territory of Hungary will be surveyed:

- A: Situations in connection with zonal western circulation (Circulation phase I.) *(zC; As; Aw)*
- B: Situations in connection with meridional orientation (Circulational phase II.)
  Within these situations there are two groups according to their appearing with a northern *(mCc; AB; CMc)* or with a southern air current *(mCw; Ae; CMw)* respectively.
- C: Situations in connection with zonal eastern circulation (Circulation phase III. *(AF; An)*
- D: Central large scale weather situations
  During the life of these the middle part of either an anticyclon *(A)* or that of a cyclon can be found above the Carpathian Basin.

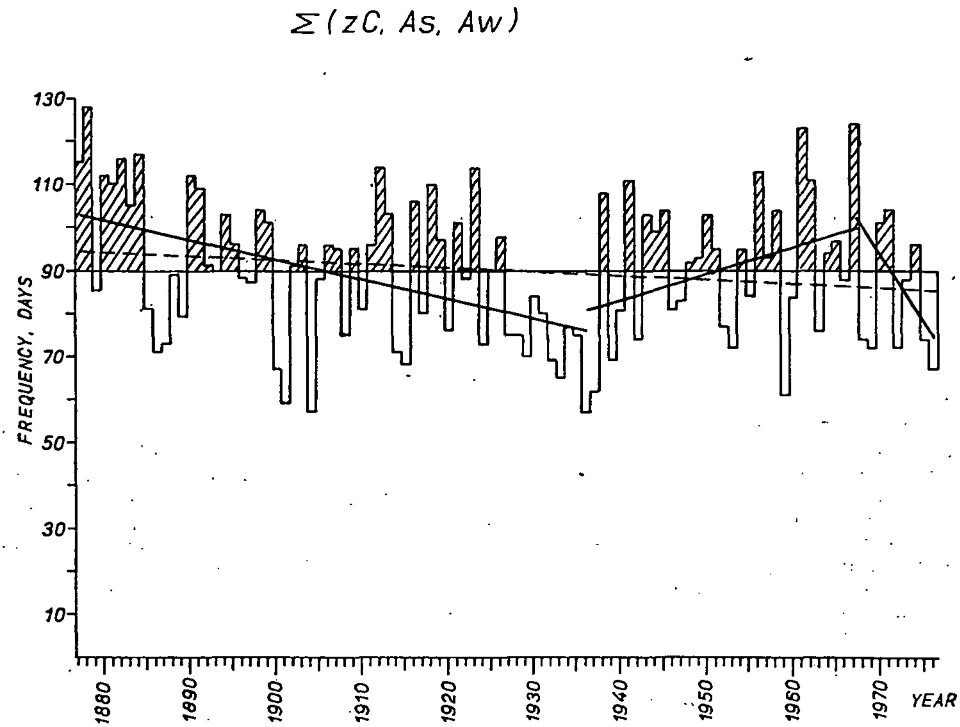

Fig. 1. Frequency and trends of weather situations of western direction

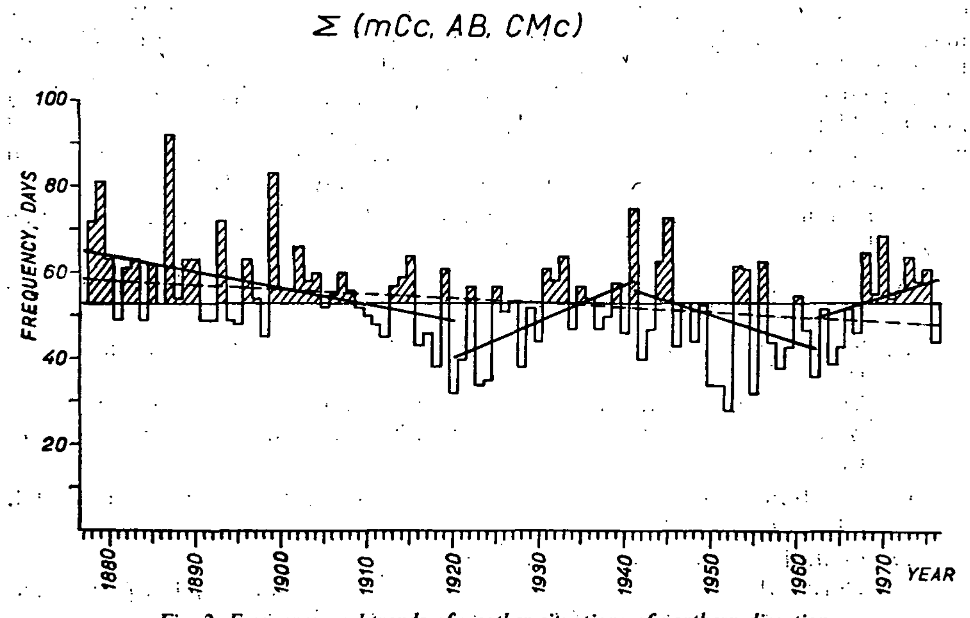

Fig. 2. Frequency and trends of weather situations of northern direction

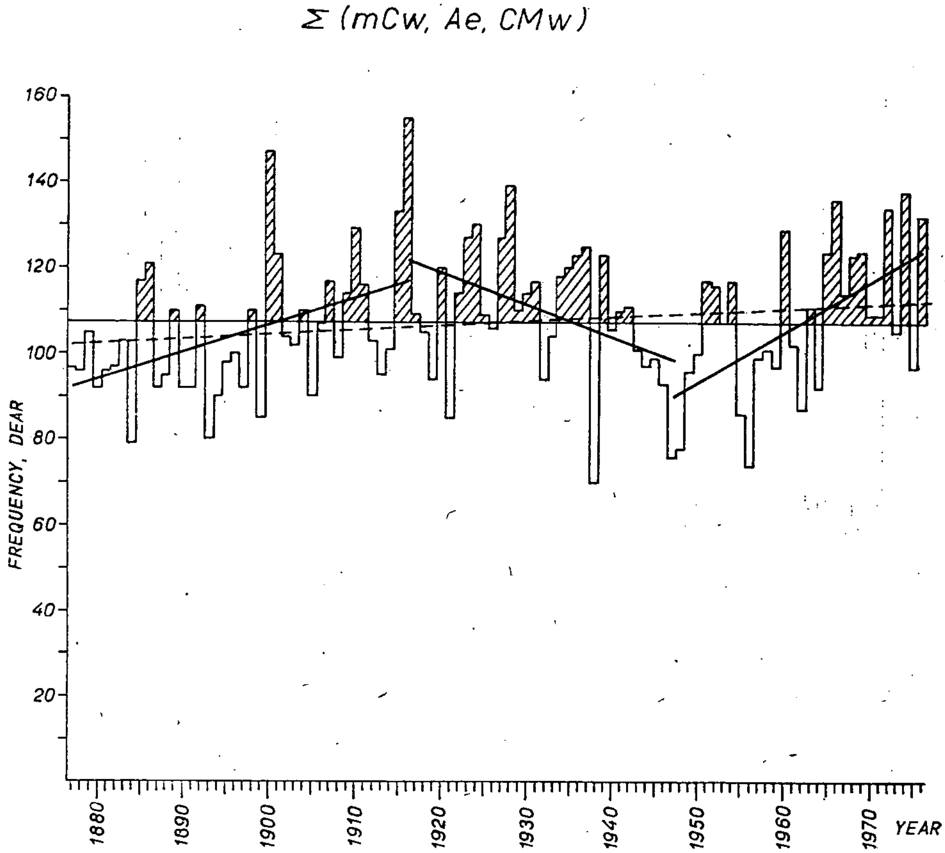

Fig. 3. Frequency and trends of weather situations of southern direction

The frequency values of the western *(Fig. 1)*, the northern *(Fig. 2)*, the southern *(Fig. 3)*, the eastern orientation *(Fig. 4)* and the anticyclon central situations *(Fig. 5)* are displayed based on the frequency time arrays of *Table 1*. The yearly incidence values of large scale weather situations of zonal and meridional currents with jointly discussed western and eastern circulation are displayed on *Fig. 6*, those with northern and southern circulation on *Fig. 7*. Since cyclon central situations are scarcely occurring circulation types, these were omitted from the analysis. On the figures the freqency mean values were indicated as well as the trend straights of individual groups referring to the examined hundred years long period or shorter periods depending on the line of frequency values. The rise of the trend straights (dotted line) calculated for the hundred years long period is rather low, which means that there is no powerful and steady unidirectional tendency in the line of frequency values of the individual situation groups during this period *(Table 4)*. Within the individual situation groups the line of trend straights indicated on the basis of the line of frequency values with a pair-wise correlation of the individual groups appears contrasting which is evident. This negative connection is apparent in the western and eastern, in the western and suothern, in the southern and anticyclonic central situations especially,

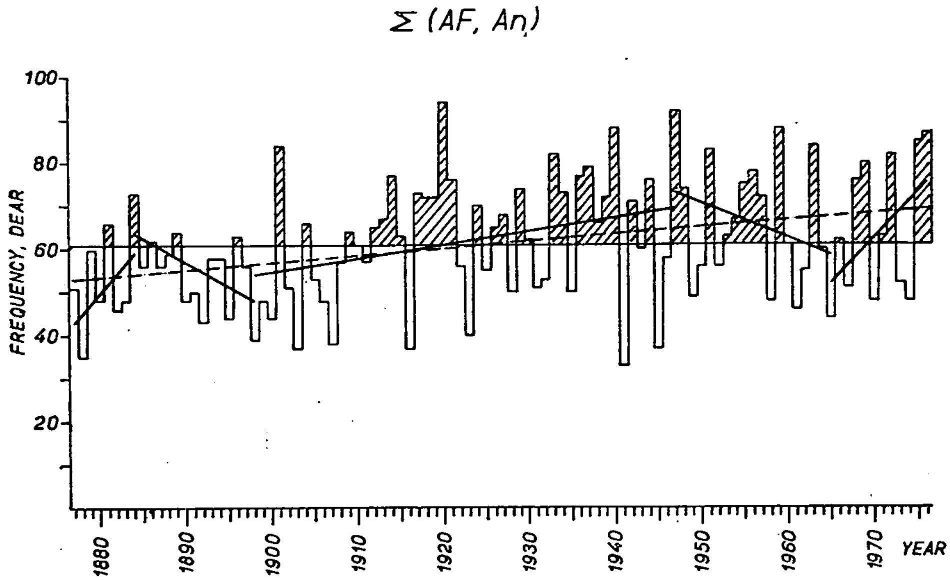

Fig. 4. Frequency and trends of weather situations of eastern direction

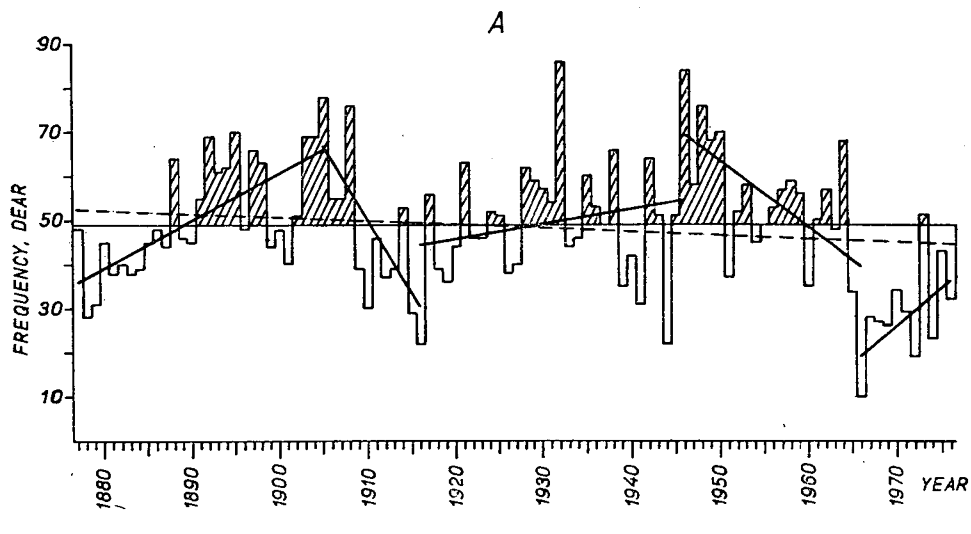

Fig. 5. Frequency and trends of the anticyclon centre weather situations

as well as in the contractionally originating situation groups with zonal and meridional orientation (correlation coefficient $= -0{,}6307$) conferring to the datas of Table 5.

Subsequently with the help of harmonic analysis the amplitudes and phase angles of periodicities of the series were calculated, which unambiguously determine the periodical waves. If the frequency values of the large scale weather situation group are denoted with a "y", with a "t" the length of time, the function describing the periodical alteration is the following:

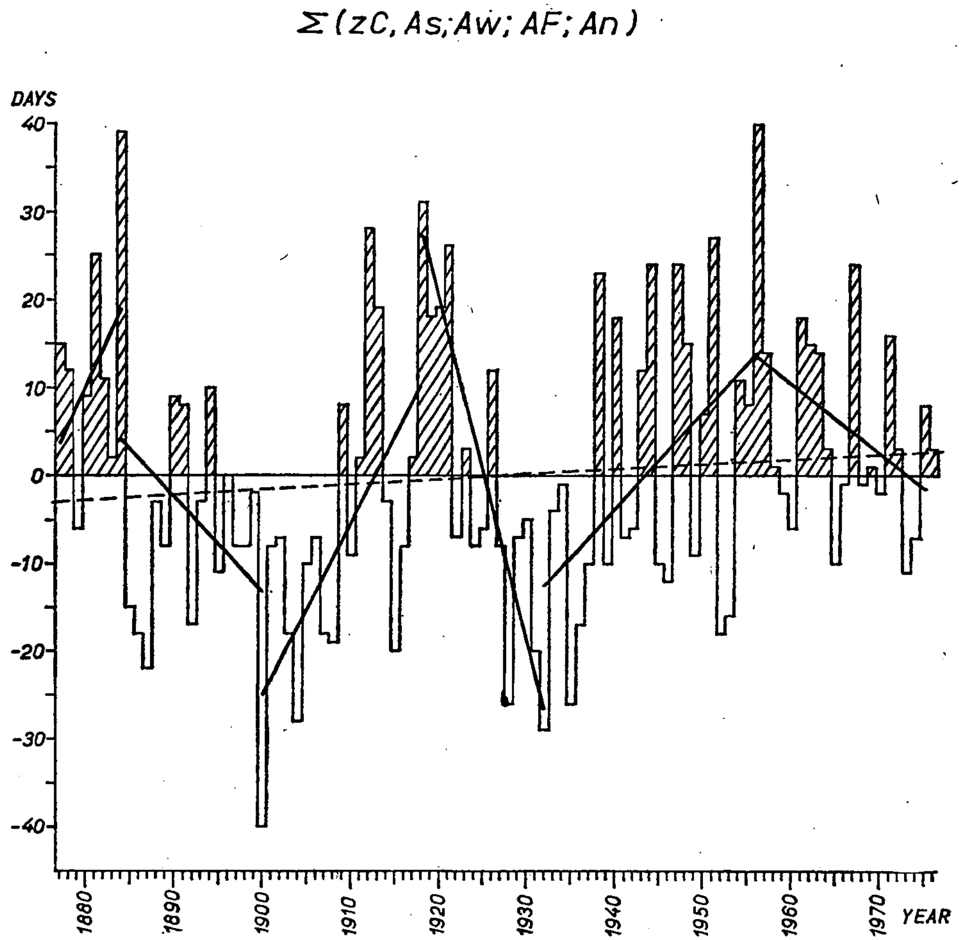

Fig. 6. Collective frequency and trends of weather situations of western and eastern directions. Zonal types

$$y = M + A \cdot \sin\left[\frac{2\pi}{T} \cdot t + U\right]$$

M is the mean value of the given situation group for this period, A is the amplitude. U is the phase angle of the wave [5]. To express the amplitude the A/E values were determined where E (expectancy) is the same as the expected values of the amplitudes. If A/E values are written in a function of the period length, the so-called periodgram curve or periodspectrum is obtained.

During this survey those periods were considered as statistically still acceptable, where A/E was superiour to 1,5 (which means that the probability that the respective period originates from a casual grouping of datas is less than 0,17). Considering this statement the periodgrams of southern orientation and anticyclon central situations indicated a definite period and a closer relation. The 3, 5 and 13 years long periods in the periodspectrum of situations with southern orientation completely correspond to the periodseries of precipitation [1], [2], of water-level [2], [3] in Hungary *(Fig 8)*. The periodgram of the anticyclon central situations shows a five years long periodicity and a quite powerful 13—14 years long periodicity *(Fig. 9)* conforming to the above-mentioned precipitation and water-level series. The situations with a southern orientation beside those with a western orientation are to bring the most rainfall in the country. Their rule in determining precipitation and water-level series in Hungary — which is assuered by a coinciding period — is best reflected if the previously indi-

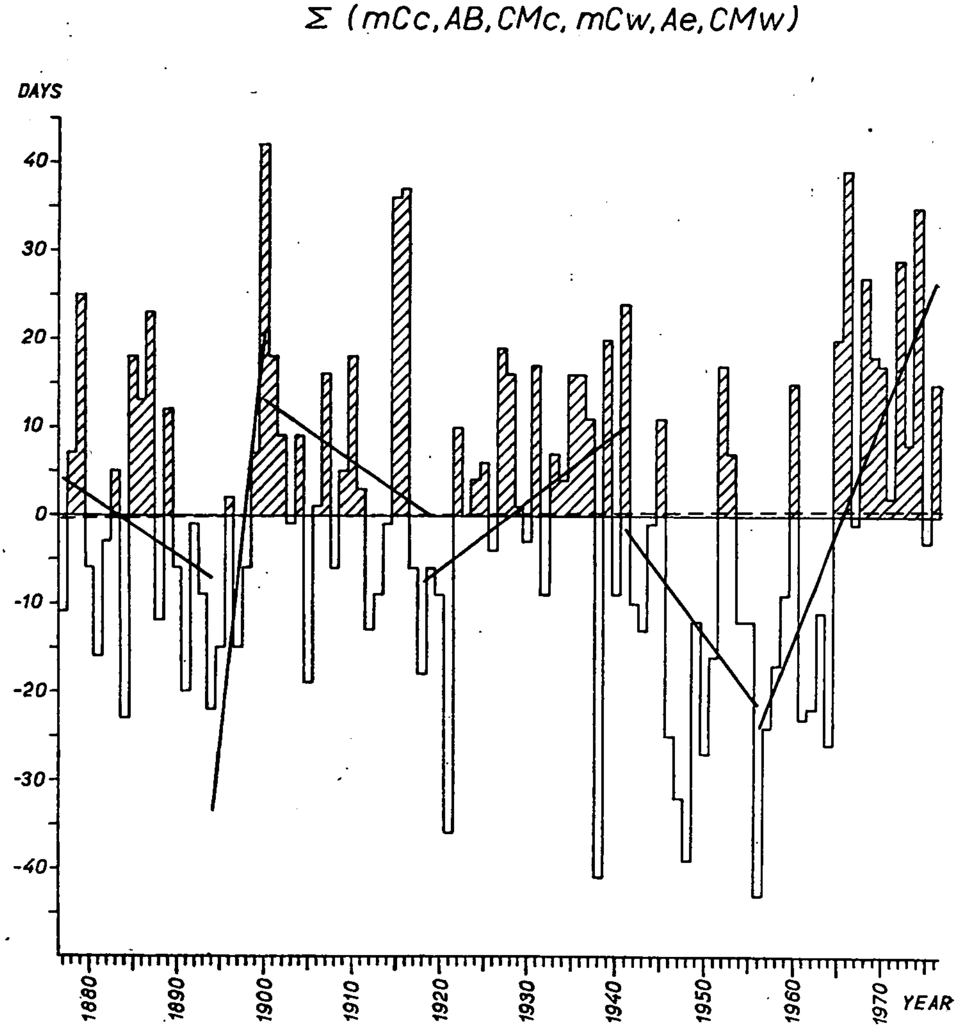

Fig. 7. Collective frequency and trends of weather situations of northern and southern directions. Meridional types

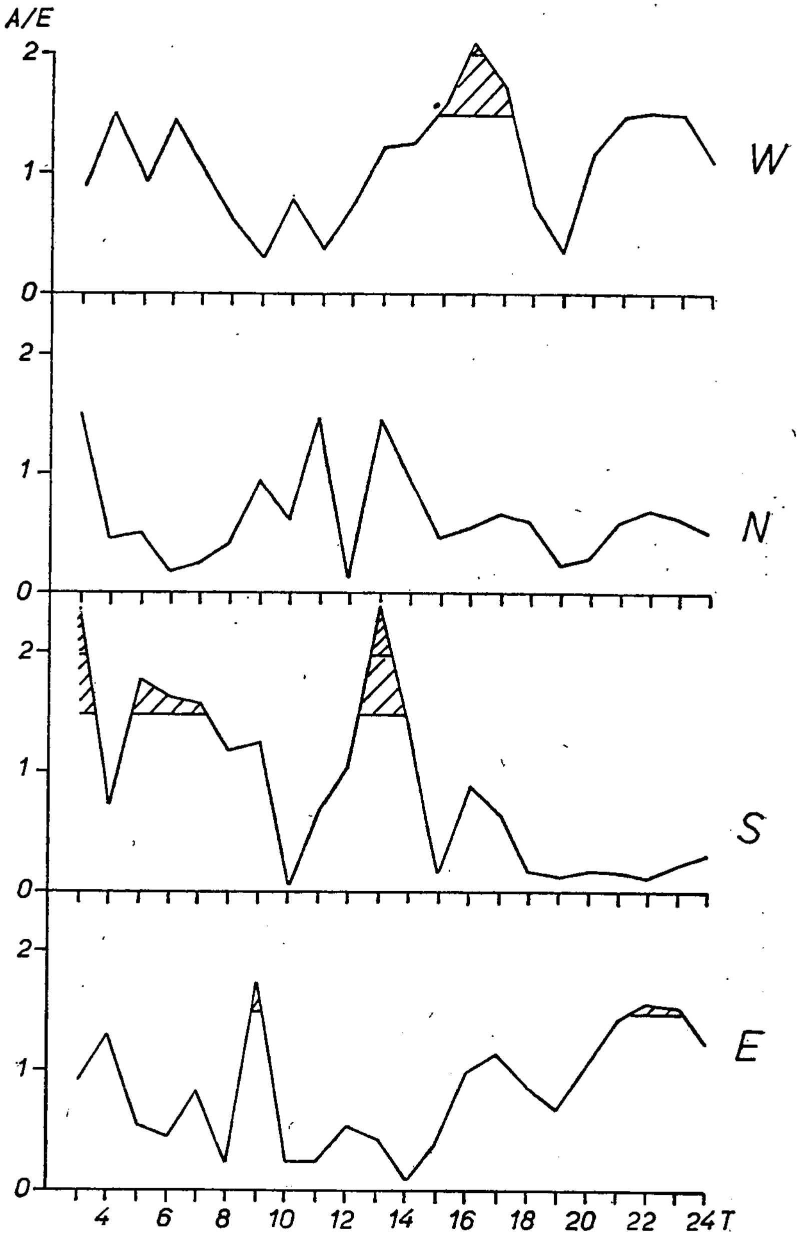

Fig. 8. Periodgrams of-weather situations of zonal and meridional directions

cated periods possess contrasting phases between the situations with southern orientation and the anticyclon central situations which is shown in the values of phase angles:

	S	A	Δ
5 years long period	204°	37°	167°
13 years long period	163°	332°	169°
14 years long period	250°	85°	165°

From this chart it can be immediately seen that the phase angles of the examined situations during the given periods are contrasting, they show a difference of almost 180°.

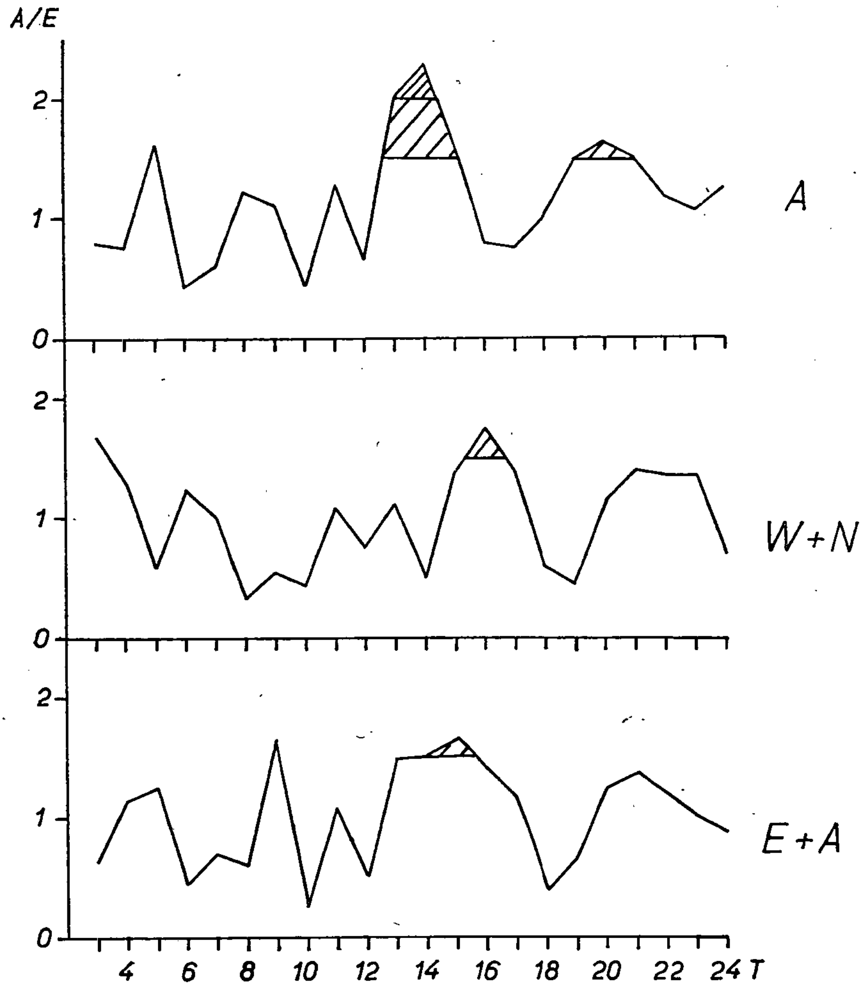

Fig. 9. Periodgrams of the anticyclon centre situations and that of the reduced groups of weather situations

On the basis of the periodspectrums and correlation calculations it can be stated that there is a reciprocal connection between the individual situations which is most characteristic between the situations with western and eastern orientation and the situation groups with zonal and meridional orientation. There is no sharp similarity between the periods of the individual situations however, and where a closer relation can be observed — first of all at the peak values of periodgrams —, there the periods are of contrasting phases.

The rhytms of influence centres of the temperate zone

In the circulation structure of the temperate zone there are certain periods which need a closer analysis comprehensing a more extensive territory in order to be able to interpret them. Consequently it is expedient to search for the reasons of periodical

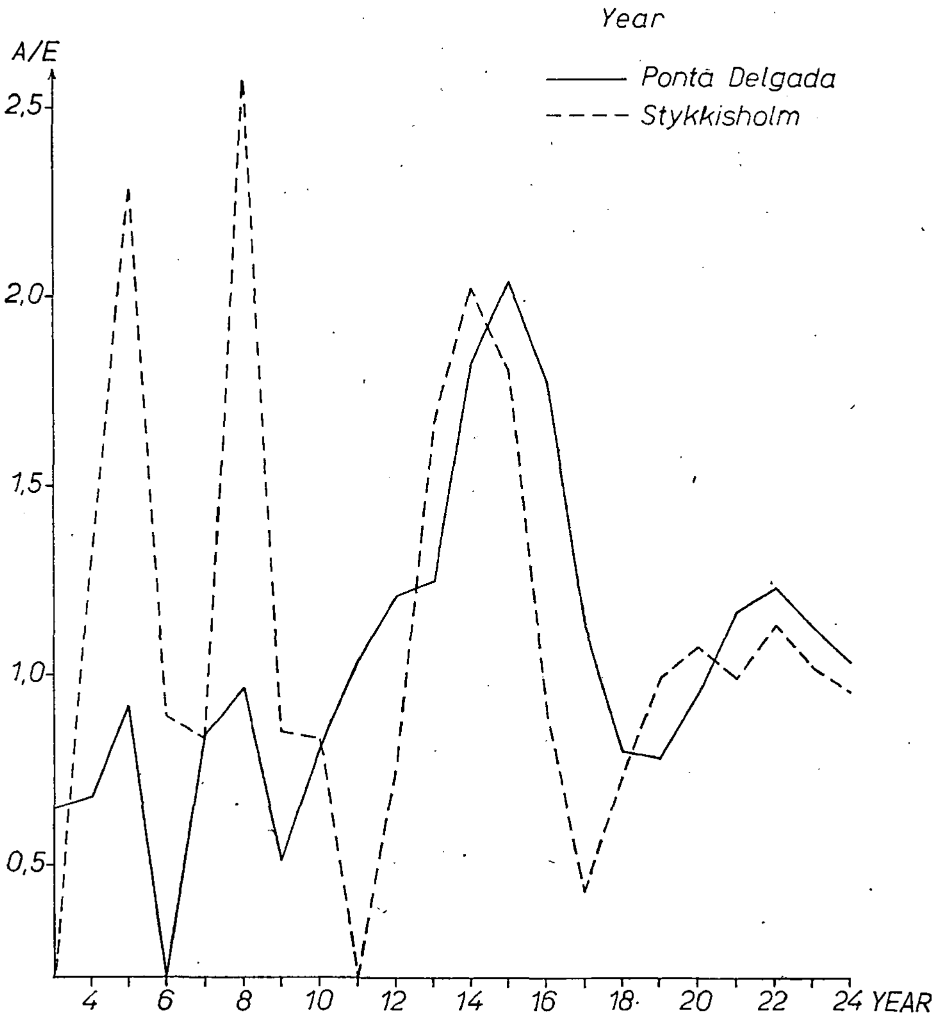

Fig. 10. Periodgrams of action centres of the Atlantic Ocean (year)

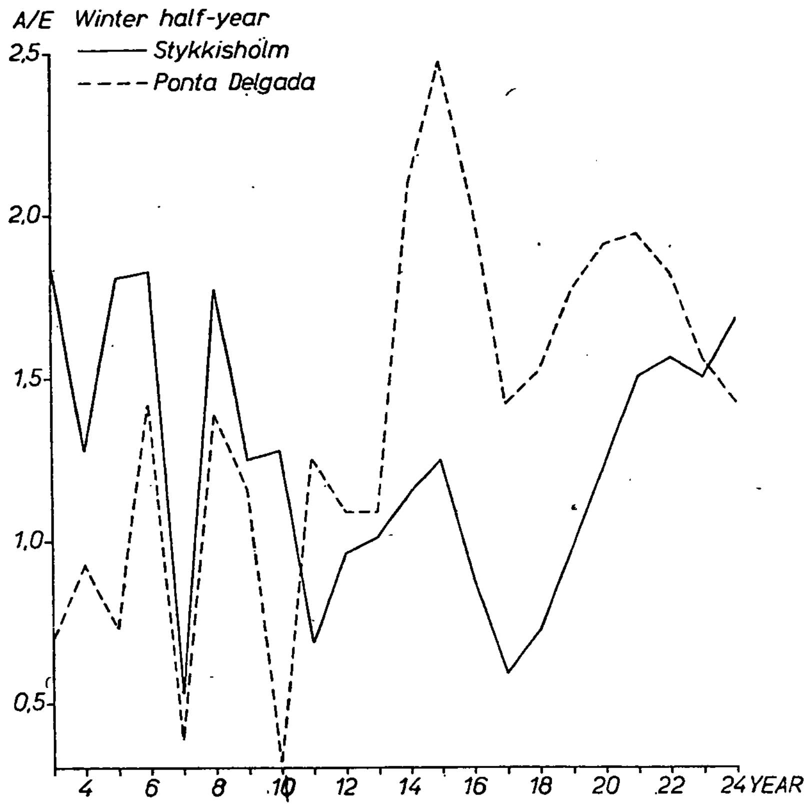

Fig. 11. Periodgrams of action centres of the Atlantic Ocean (winter halfyear)

frequency of large scale weather situations characteristic of Hungary by maens of the exploration and processing of the birthplaces of these positions, by analysing the thermodynamic characteristics of the influence centres of the Atlantic Ocean, since these centres of action determine the intensity of zonal circulation. Additionally a study of factors in connection with the activity and relation of the Atlantic and Pacific Ocean influence centres of the temperate zone was included.

The basis of elaboration was constituted by the following set of datas: in the case of Atlantic influence centres Stykkisholm on the Icelandic territory with low air pressure, 67 years long, between 1894—1960 time array of monthly mean air pressures and that of station Ponta Delgada which is under the influence of the Azores barometrical maximum while a 44 years long, between 1917—1960, similar time array was analysed in the territory of the Pacific Ocean, as a low air-pressure influence centre Dutch Harbor, as a high one Honolulu station was chosen in Hawai and Aleut respectively *(Table 6 and 7)*.

With the method of harmonic analysis the time arrays of yearly, summer and winter air-pressure mean values measured at the representative stations of the Atlantic centres of action were processed, and the periods apparent in the values were plotted on *Fig. 10, 11 and 12.* The periodgrams of pressure differences of respective time arrays of Stykkisholm and Ponta Delgada stations were plotted considering the same three instances. In the periodgrams of pressure differences the phase angle differences belonging to still realistic periods (A/E is superior to 1,5) mostly values around 180° are obtained. Which means that western circulation is much more prevalent in the mentioned circulations. With a more detailed analysis of the periodgram of the time array including the yearly Δ p values of Atlantic centres of influence a definite 5 years and 13 years long periods as well as a rather strong 8 years long and a 14—15 years long periods are found.

This analysis of periodicity on the basis of yearly mean air-pressure values of Atlantic and Pacific centres of influence could register an identical and significant 13—14 years long periods only in the case of centres with low air-pressure, that is, in the case of Aleuti and Icelandic stations.

This direct relation between the two centres of action, as a consequency of the shape of the Earth — might be promoted by the lesser distance between them comparing to centres of high pressure.

Summing up it can be stated that there are no sharp similarities in the periods of large scale weather situation groups determining the climate of Hungary. While there are characteristic 5 and 13—14 years long periods int he periodspectrums of anticyclon central situations and those with a southern orientation. These periods are identical with the 5 and 15 years periods in the periodgram of time array of yearly mean rainfall, elaborated on the basis of data from 10 Hungarian stations between 1871 and 1972. The more powerful rule of the situations with southern orientation in the precip-

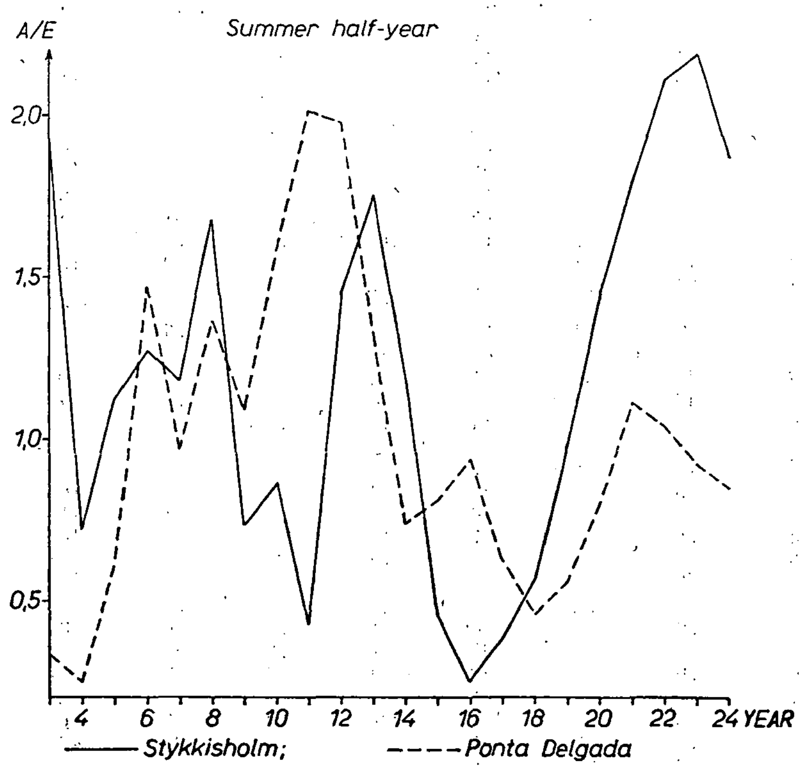

Fig. 12. Periodgrams of action centres of the Atlantic Ocean (summer halfyear)

itation supply of Hungary is confirmed by their contrasting phase with the anticyclonic situations beside the identical periods of the respective time arrays. The periods appearing in the periodspectrum of the time array including the yearly Δ p values of Atlantic centres of influence are similar to the periods of time array of rainfall in question. The almost identical phase angle values belonging to the 14 years long period of above-mentioned time arrays mean that the majority of rainfall happened in connection with air currents originating at the Atlantic Ocean, at least that was the case during the indicated 14 years long period.

These 13—14 years long periods are characteristic not only of the yearly mean rainfall line in Hungary and in the circulation relations of the North-Atlantic territory which determines the previous, but in the circulation structure in connection with the low air-pressure centres of action on the northern hemisphere as well.

Table 1/a

Annual frequency of large-scale weather situations of Hungary, days (1877—1976)

Year	*zC*	*As*	*Aw*	Summ.	*mCc*	*AB*	*CMc*	Summ.
1877	26	34	55	115	31	9	13	53
1878	21	32	75	128	38	14	20	72
1879	15	15	55	85	44	25	12	81
1880	31	33	48	112	27	31	5	63
1881	25	26	59	110	29	16	4	49
1882	27	19	70	116	25	29	7	61
1883	21	34	50	105	33	21	9	63
1884	15	34	68	117	19	19	11	49
1885	22	16	43	81	28	25	9	62
1886	18	19	34	71	20	23	10	53
1887	12	17	44	73	38	45	9	92
1888	22	29	38	89	25	16	13	54
1889	17	9	53	79	25	22	16	63
1890	31	33	48	112	27	31	5	63
1891	22	20	67	109	23	20	6	49
1892	15	21	55	91	18	19	12	49
1893	26	26	38	90	29	37	6	72
1894	17	31	55	103	18	25	6	49
1895	19	24	53	96	12	25	11	48
1896	23	19	46	88	21	35	7	63
1897	19	19	49	87	27	17	10	54
1898	13	16	75	104	11	27	7	45
1899	24	36	41	101	28	42	13	83
1900	17	12	38	67	19	17	20	56
1901	19	8	32	59	31	19	6	56
1902	36	17	38	91	33	17	16	66
1903	33	39	24	96	34	13	11	58
1904	24	13	20	57	19	27	14	60
1905	22	9	57	88	20	25	7	52
1906	28	13	55	96	18	24	13	55
1907	11	22	62	95	32	25	3	60
1908	20	21	34	75	22	26	8	56
1909	31	17	47	96	28	20	4	52
1910	29	15	37	81	24	19	7	50
1911	27	24	45	96	11	35	2	48
1912	28	38	48	114	24	15	6	45
1913	24	39	40	103	22	23	12	57
1914	22	23	26	71	22	32	5	59
1915	15	16	37	68	31	23	10	64

Year	*zC*	*As*	*Aw*	Summ.	*mCc*	*AB*	*CMc*	Summ.
1916	25	26	55	106	20	17	6	53
1917	14	26	40	80	11	30	5	46
1918	17	42	51	110	8	26	4	38
1919	18	28	51	97	20	30	11	61
1920	10	21	45	76	16	16	—	32
1921	17	40	44	101	21	18	1	40
1922	19	17	52	88	26	21	10	57
1923	23	30	61	114	22	7	5	34
1924	25	12	36	73	22	7	6	35
1925	36	26	28	90	36	17	4	57
1926	33	27	38	98	18	27	6	51
1927	22	19	34	75	22	24	7	53
1928	17	22	36	75	14	15	9	38
1929	17	17	36	70	15	31	6	52
1930	44	10	30	84	17	20	7	44
1931	22	21	37	80	23	33	5	61
1932	16	19	34	69	23	28	7	58
1933	17	21	27	65	23	37	4	64
1934	16	16	45	77	17	28	2	47
1935	20	13	42	75	21	25	11	57
1936	9	10	38	57	30	16	8	54
1937	22	11	29	62	24	12	11	47
1938	16	28	64	108	16	28	6	50
1939	12	24	33	69	20	16	22	58
1940	24	15	42	81	21	15	10	46
1941	24	32	55	111	39	26	10	75
1942	12	17	45	74	17	17	6	40
1943	29	9	65	103	26	15	6	47
1944	35	9	55	99	41	16	6	63
1945	31	30	43	104	27	33	13	73
1946	21	11	49	81	14	24	5	43
1947	27	15	41	83	22	23	8	53
1948	25	20	47	92	24	14	6	44
1949	17	9	67	93	27	23	3	53
1950	31	9	63	103	19	7	8	34
1951	22	14	59	95	10	8	10	28
1952	23	7	47	77	20	24	18	62
1953	15	11	46	72	13	33	15	61
1954	24	6	65	95	18	6	8	32
1955	29	7	48	84	34	22	10	63
1956	27	24	62	113	10	21	13	44
1957	26	12	55	93	22	9	7	38
1958	32	24	48	104	29	3	11	43
1959	12	14	35	61	17	31	7	55
1960	29	12	43	84	31	7	9	47
1961	28	19	76	123	9	21	6	36
1962	28	16	67	111	25	15	12	52
1963	20	10	46	76	11	18	10	39
1964	14	10	70	94	15	19	9	43
1965	21	15	61	97	19	24	14	57
1966	11	16	61	88	26	16	22	64
1967	18	25	81	124	14	20	12	46
1968	17	16	41	74	33	24	8	65
1969	13	10	49	72	22	9	24	55
1970	15	18	68	101	35	17	17	69
1971	15	10	79	104	17	28	9	54
1972	16	14	42	72	14	29	13	56
1973	20	6	62	88	18	32	14	64
1974	19	21	56	96	29	15	14	58
1975	8	12	54	74	12	39	10	61
1976	6	9	52	67	17	20	7	44

Table 1/b

Annual frequency of large-scale weather situations of Hungary, days (1877—1976)

Year	*mCw*	*Ae*	*CMw*	Summ.	*AF*	*An*	Summ.	*A*	*C*
1877	50	33	14	97	6	45	51	48	1
1878	47	37	12	96	7	28	35	28	5
1879	47	41	17	105	14	46	60	31	3
1880	35	42	15	92	20	28	48	45	6
1881	32	50	14	96	29	37	66	38	6
1882	47	31	19	97	24	22	46	40	5
1883	36	56	11	103	13	35	48	38	8
1884	23	33	23	79	19	54	73	39	8
1885	61	39	17	117	2	53	55	45	5
1886	45	47	29	121	21	41	62	48	10
1887	36	31	25	92	9	47	56	44	7
1888	37	36	22	95	32	27	59	64	5
1889	37	47	26	110	27	37	64	46	3
1890	35	42	15	92	21	27	48	45	6
1891	37	39	16	92	14	36	50	55	10
1892	39	50	22	111	6	37	43	69	2
1893	25	39	16	80	27	31	58	61	4
1894	17	50	23	90	17	40	58	62	3
1895	39	33	26	98	11	33	44	70	9
1896	27	47	26	100	7	59	63	48	4
1897	29	39	24	92	24	32	56	66	10
1898	40	53	17	110	14	25	39	63	4
1899	30	31	25	85	18	30	48	44	4
1900	44	66	37	147	13	31	44	48	3
1901	42	49	22	123	40	44	84	40	3
1902	33	46	25	104	27	24	51	51	2
1903	39	36	27	102	16	21	37	69	3
1904	25	60	25	110	20	46	66	69	4
1905	29	40	21	90	9	44	53	78	4
1906	38	38	31	107	25	23	48	55	4
1907	30	62	25	117	8	30	38	55	—
1908	31	48	20	99	25	32	57	76	3
1909	51	48	15	114	9	55	64	39	1
1910	43	62	24	129	4	57	61	30	6
1911	36	62	18	116	13	44	57	46	1
1912	45	42	16	103	18	47	65	37	2
1913	31	51	13	95	21	46	67	39	4
1914	46	41	14	101	30	47	77	53	4
1915	48	57	28	133	14	49	63	29	8
1916	64	76	15	155	15	22	37	22	3
1917	44	38	27	109	25	48	73	56	1
1918	32	53	20	105	17	55	72	39	1
1919	47	21	26	94	22	50	72	36	5
1920	28	35	7	70	20	74	94	44	1
1921	27	42	16	85	19	57	76	63	—
1922	54	37	23	114	12	44	56	46	4
1923	59	45	23	127	18	22	40	46	4
1924	44	70	16	130	23	47	70	52	6
1925	52	33	24	109	21	34	55	51	3
1926	43	40	23	106	13	52	65	38	7
1927	58	49	20	127	30	38	68	40	2
1928	51	68	20	139	16	34	50	62	2
1929	34	61	15	110	13	61	74	59	—
1930	46	39	29	114	24	38	62	57	2
1931	51	44	22	117	14	37	51	54	2
1932	40	45	9	94	20	33	53	86	6

Year	mCw	Ae	CMw	Summ.	AF	An	Summ.	A	C
1933	33	43	28	104	44	38	82	44	6
1934	56	46	16	118	13	60	73	46	4
1935	41	49	30	120	28	22	50	60	3
1936	53	47	23	123	40	37	77	53	2
1937	60	44	21	125	23	56	79	49	3
1938	25	30	15	70	16	50	66	66	5
1939	36	50	37	123	24	48	72	35	8
1940	36	46	24	106	35	53	88	42	3
1941	48	43	19	110	2	31	33	31	5
1942	31	69	11	111	23	48	71	64	5
1943	17	69	15	101	5	55	60	51	3
1944	56	32	9	97	7	69	76	22	6
1945	35	39	25	99	15	22	37	51	1
1946	19	47	27	93	8	50	58	84	6
1947	18	38	20	76	44	48	92	58	3
1948	19	39	20	78	19	55	74	76	2
1949	23	63	10	96	4	45	49	68	6
1950	43	27	30	100	14	41	55	70	3
1951	39	51	27	117	14	69	83	37	5
1952	53	38	25	116	18	38	56	52	3
1953	17	70	20	107	13	50	63	58	4
1954	45	43	29	117	21	46	67	45	9
1955	28	42	16	86	19	56	75	49	8
1956	20	40	14	74	38	40	78	53	4
1957	33	55	11	99	16	56	72	57	6
1958	45	38	18	101	2	46	48	59	11
1959	25	51	21	97	26	62	88	56	8
1960	57	39	33	129	14	47	61	35	10
1961	35	44	23	102	7	39	46	50	8
1962	17	37	33	87	9	46	55	57	3
1963	34	50	27	111	13	71	84	48	7
1964	26	43	23	92	9	51	60	68	9
1965	53	40	31	124	13	31	44	34	9
1966	56	38	42	136	14	48	62	10	5
1967	37	57	20	114	6	45	51	28	2
1968	48	53	22	123	16	60	76	27	1
1969	51	40	33	134	14	66	80	26	8
1970	62	24	23	109	9	39	48	34	4
1971	30	45	34	109	10	53	63	29	6
1972	15	84	35	134	15	67	82	19	3
1973	29	49	27	105	12	40	52	51	5
1974	33	74	31	138	5	43	48	23	2
1975	31	47	19	97	17	68	85	43	5
1976	38	70	24	132	28	59	87	32	4

Table 2/a

Winter half-yearly frequency of large-scale weather situations of Hungary, days (1877—1976)

Year	zC	As	Aw	Summ.	mCc	AB	CMc	Summ.
1877—78	8	14	32	54	13	10	8	31
1878—79	5	12	29	46	21	2	9	32
1879—80	5	8	15	28	10	35	4	49
1880—81	23	18	26	67	14	7	2	23
1881—82	5	9	38	52	5	8	2	15
1882—83	14	16	16	46	12	7	3	22
1883—84	15	19	30	64	6	4	3	13
1884—85	7	18	20	45	5	10	1	16
1885—86	8	9	8	25	12	3	7	22

Year	mCw	Ae	CMw	Summ.	AF	An	Summ.	A	C
1886—87	4	11	4	29	14		15	3	32
1887—88	12	14	16	42	15		8	9	32
1888—89	11	12	15	38	10		8	8	26
1889—90	5	6	18	29	4		15	2	21
1890—91	20	21	31	72	8		7	4	19
1991—92	13	12	10	35	12		14	3	29
1892—93	11	20	15	46	8		9	4	21
1893—94	10	13	31	54	5		7	2	14
1894—95	12	7	14	33	8		5	5	18
1895—96	14	15	18	47	6		18	3	27
1896—97	18	5	21	44	9		8	1	18
1897—98	7	10	31	48	5		6	4	15
1898—99	7	26	11	44	11		15	5	31
1899—00	1	5	25	31	7		6	11	24
1900—01	9	13	10	32	7		4	6	17
1901—02	13	11	21	45	13		13	5	31
1902—03	10	32	13	55	7		6	5	18
1903—04	15	8	6	29	10		7	2	19
1904—05	16	8	16	40	8		17	6	31
1905—06	16	11	27	54	10		14	4	28
1906—07	13	1	26	40	11		15	5	31
1907—08	10	14	5	29	11		6	4	21
1908—09	10	—	14	24	5		9	2	16
1909—10	17	8	14	39	4		13	4	21
1910—11	14	7	19	40	12		16	1	29
1911—12	17	18	14	49	3		2	2	7
1912—13	12	29	14	55	1		11	3	15
1913—14	25	16	18	59	9		7	1	17
1914—15	5	8	11	24	13		9	5	27
1915—16	18	13	22	53	6		2	6	14
1916—17	8	14	14	36	2		6	4	12
1917—18	7	30	18	55	5		10	2	17
1918—19	9	9	4	22	2		10	3	15
1919—20	17	9	21	47	11		9	4	24
1920—21	4	16	17	37	5		2	—	7
1921—22	16	14	12	42	11		6	6	23
1922—23	7	6	19	32	12		10	3	25
1923—24	14	6	5	25	18		2	7	27
1924—25	11	16	16	43	2		5	—	7
1925—26	18	7	8	33	7		10	7	24
1926—27	4	15	15	34	9		9	5	23
1927—28	10	8	7	25	4		11	3	18
1928—29	2	9	7	18	8		15	5	28
1929—30	11	7	7	25	3		8	4	15
1930—31	15	5	9	29	12		11	4	27
1931—32	5	11	11	27	5		28	—	33
1932—33	3	9	9	21	6		9	2	17
1933—34	6	8	11	25	—		13	3	16
1934—35	11	11	18	40	5		6	5	16
1935—36	5	5	10	20	4		3	6	13
1936—37	11	9	12	32	8		4	10	22
1937—38	9	16	30	55	7		18	2	27
1938—39	9	16	21	46	9		6	10	25
1939—40	7	15	10	32	12		—	9	21
1940—41	17	9	10	36	9		8	6	23
1941—42	11	14	12	37	10		7	2	19
1942—43	12	12	20	46	6		6	2	14
1943—44	20	4	32	56	20		2	2	24
1944—45	23	20	16	59	6		11	5	22
1945—46	16	14	6	36	13		21	1	35
1946—47	7	6	9	22	7		10	7	24

Year	zC	As	Aw	Summ.	mCc	AB	CMc	Summ.
1947—48	21	12	24	57	10	16	4	30
1948—49	7	6	24	37	11	8	—	19
1949—50	18	7	19	44	10	4	4	18
1950—51	16	6	17	39	6	2	9	17
1951—52	8	9	22	39	12	10	8	30
1952—53	15	8	17	40	6	19	17	42
1953—54	6	5	8	19	4	5	3	12
1954—55	19	4	19	42	16	2	5	23
1955—56	21	9	19	49	6	10	6	22
1956—57	6	16	20	42	2	6	3	11
1957—58	13	11	21	45	6	1	11	18
1958—59	6	8	16	30	12	8	2	22
1959—60	9	6	13	28	2	—	6	8
1960—61	14	11	40	65	3	1	7	11
1961—62	8	12	22	42	10	14	2	26
1962—63	5	3	8	16	4	9	6	19
1963—64	12	3	19	34	6	8	3	17
1964—65	7	5	21	33	5	21	10	36
1965—66	15	12	27	54	11	9	11	31
1966—67	7	13	31	51	9	5	3	17
1967—68	16	15	38	69	16	7	2	25
1968—69	3	8	16	27	6	2	9	17
1969—70	15	6	16	37	8	3	10	21
1970—71	4	15	33	52	8	9	9	26
1971—72	9	9	32	50	1	9	3	13
1972—73	8	9	29	46	4	22	5	31
1973—74	12	10	25	47	6	6	2	14
1974—75	3	22	32	57	16	3	8	27
1975—76	4	5	35	44	6	12	2	20
1976—77	8	7	17	32	6	10	5	21

Table 2/b

Winter half-yearly frequency of large-scale weather situations of Hungary, days (1877—1976)

Year	mCw	Ae	CMw	Summ.	AF	An	Summ.	A	C
1877—78	15	25	9	49	2	22	24	24	—
1878—79	32	31	11	47	7	12	19	7	3
1879—80	6	20	7	33	5	25	30	43	—
1880—81	26	27	4	57	6	12	18	17	—
1881—82	11	26	9	46	9	9	18	49	2
1882—83	26	46	8	80	10	12	22	10	2
1883—84	14	36	6	56	1	19	20	24	5
1884—85	16	25	15	56	1	41	42	22	1
1885—86	27	27	17	71	8	30	38	19	7
1886—87	28	16	13	57	11	24	35	27	2
1887—88	23	14	25	62	8	7	15	28	4
1888—89	14	30	11	55	11	11	22	38	3
1889—90	11	36	12	59	10	16	26	48	—
1890—91	17	14	12	43	—	11	11	35	2
1891—92	22	42	9	73	5	18	23	19	2
1892—93	13	32	11	56	7	21	28	29	2
1893—94	8	35	7	50	9	14	23	39	2
1894—95	21	21	27	69	4	26	30	25	7
1895—96	14	19	9	42	6	21	27	38	2
1896—97	20	35	14	69	3	24	27	22	2
1897—98	16	32	10	58	15	5	20	41	—
1898—99	16	25	12	53	9	8	17	36	1
1899—00	28	35	22	85	3	12	15	25	2

Year	mCw	Ae	CMw	Summ.	AF	An	Summ.	A	C
1900—01	19	28	21	68	5	22	27	37	1
1901—02	29	31	12	72	3	14	17	16	1
1902—03	8	25	17	50	16	12	28	31	—
1903—04	20	45	22	87	4	21	25	23	—
1904—05	12	27	14	53	8	23	31	26	1
1905—06	20	21	16	57	—	14	14	26	3
1906—07	18	26	12	56	9	21	30	24	1
1907—08	22	46	13	81	8	13	21	31	—
1908—09	17	26	16	59	9	30	39	44	—
1909—10	30	37	15	82	3	22	25	15	—
1910—11	13	47	12	72	4	20	24	17	—
1911—12	32	43	11	86	7	15	22	18	1
1912—13	19	31	5	55	7	20	27	30	—
1913—14	18	15	8	41	4	16	20	44	1
1914—15	38	36	12	86	5	23	28	14	3
1915—16	26	41	15	82	7	16	23	8	3
1916—17	36	30	22	88	7	21	28	18	—
1917—18	13	24	12	49	2	35	37	24	—
1918—19	36	39	16	91	6	34	40	12	2
1919—20	21	31	12	64	—	30	30	15	3
1920—21	17	46	5	68	7	29	36	34	—
1921—22	11	23	17	51	5	18	23	41	2
1922—23	25	35	10	70	8	23	31	21	3
1923—24	41	23	13	77	6	21	27	24	3
1924—25	15	41	15	71	7	19	26	35	—
1925—26	22	27	12	61	2	33	35	29	—
1926—27	43	27	13	83	4	14	18	20	4
1927—28	18	46	15	79	16	20	36	24	1
1928—29	23	28	14	65	13	27	40	31	—
1929—30	27	59	12	98	—	17	17	25	2
1930—31	27	28	23	78	7	17	24	23	1
1931—32	10	35	9	54	7	20	27	42	—
1932—33	17	47	13	77	9	22	31	33	3
1933—34	28	25	18	71	3	34	37	30	3
1934—35	22	36	14	72	13	20	33	20	1
1935—36	35	53	27	115	4	12	16	18	1
1936—37	28	37	13	78	—	21	21	26	3
1937—38	17	15	7	39	3	30	33	28	—
1938—39	16	30	15	61	4	16	20	27	3
1939—40	9	36	20	65	20	16	36	25	3
1940—41	29	26	19	74	8	22	30	15	4
1941—42	10	34	14	58	13	30	43	22	3
1942—43	6	46	4	56	—	27	27	37	2
1943—44	13	25	7	45	5	30	35	20	3
1944—45	29	14	14	57	5	28	33	9	2
1945—46	16	27	16	59	5	20	25	25	2
1946—47	20	31	22	73	12	25	37	22	4
1947—48	7	11	18	36	10	22	32	27	1
1948—49	7	30	2	39	7	27	34	52	1
1949—50	12	34	14	60	11	27	38	20	2
1950—51	33	24	33	90	2	14	16	17	3
1951—52	24	23	14	61	8	25	33	19	1
1952—53	23	15	17	55	4	24	28	15	2
1953—54	12	63	10	85	11	27	38	28	—
1954—55	21	24	15	60	1	33	34	22	1
1955—56	11	30	5	46	19	26	45	16	5
1956—57	13	21	11	45	19	22	41	40	3
1957—58	20	25	11	56	4	26	30	30	3
1958—59	22	36	8	66	1	18	19	42	3
1959—60	16	44	18	78	6	35	41	24	4
1960—61	35	15	19	69	4	11	15	16	6

1961—62	24	24	15	63	8	25	33	13	5
1962—63	14	17	31	62	5	47	52	32	1
1963—64	16	27	10	53	6	26	32	44	3
1964—65	14	29	23	66	1	23	24	21	3
1965—66	27	15	12	54	5	24	29	11	3
1966—67	30	37	20	87	2	19	21	5	1
1967—68	19	30	8	57	—	13	13	19	—
1968—69	23	30	17	70	7	45	52	14	2
1969—70	30	22	20	72	2	35	37	11	4
1970—71	18	13	22	53	5	27	32	17	2
1971—72	4	59	22	85	3	19	22	12	1
1972—73	6	41	13	60	4	28	32	12	1
1973—74	14	53	13	80	1	18	19	22	—
1974—75	17	26	15	58	2	18	20	19	1
1975—76	8	38	10	56	5	34	39	22	2
1976—77	31	58	17	106	—	10	10	10	3

Table 3/a

Summer half-yearly frequency of large-scale weather situations of Hungary, days (1877—1976)

Year	*zC*	*As*	*Aw*	Summ.	*mCc*	*AB*	*CMc*	Summ.
1877	7	21	36	64	18	9	7	34
1878	12	13	43	68	20	3	7	30
1879	13	8	34	55	23	2	6	31
1880	13	11	20	44	20	15	5	40
1881	11	22	43	76	19	9	2	30
1882	16	3	33	52	17	22	3	42
1883	9	22	27	58	22	14	7	43
1884	6	8	37	51	16	13	8	37
1885	14	4	33	51	13	16	6	35
1886	10	6	27	43	15	15	5	35
1887	8	9	23	40	19	31	1	51
1888	11	13	26	50	15	12	9	36
1889	8	6	37	51	16	15	7	38
1890	13	11	20	44	20	15	5	40
1891	11	8	50	69	16	8	2	26
1892	5	10	38	53	10	10	7	27
1893	14	9	18	41	19	29	4	52
1894	6	17	33	56	14	16	4	34
1895	6	7	40	53	4	19	4	27
1896	11	15	25	51	15	18	6	39
1897	3	9	28	40	18	9	7	34
1898	5	9	45	59	6	21	3	30
1899	18	10	22	50	15	25	9	49
1900	12	1	24	37	13	17	6	36
1901	7	2	15	24	24	10	2	36
1902	22	8	22	52	20	6	10	36
1903	28	1	14	43	22	4	9	35
1904	5	9	14	28	11	17	6	34
1905	8	—	34	42	11	5	5	21
1906	10	7	32	49	11	19	7	37
1907	6	12	43	61	21	12	2	35
1908	10	16	23	49	15	15	4	34
1909	11	12	33	56	21	12	—	33
1910	17	6	24	47	22	9	4	35
1911	12	16	28	56	5	19	2	26
1912	11	13	28	52	22	13	1	36
1913	8	21	24	53	19	14	11	44
1914	7	13	19	39	14	23	5	42
1915	5	7	26	38	15	17	2	34

Year	*mCw*	*Ae*	*CMw*	Summ.	*AF*	*An*	Summ.	*A*	*C*
1916	8	11	28	47		19	13	1	33
1917	6	15	23	44		7	23	1	31
1918	12	19	42	73		4	15	3	22
1919	3	15	43	61		10	20	5	35
1920	2	9	29	40		14	12	—	26
1921	4	22	22	48		9	16	1	26
1922	10	9	37	56		16	5	1	21
1923	6	22	48	76		8	6	1	15
1924	18	11	28	57		13	3	3	19
1925	15	10	18	43		30	11	—	41
1926	26	13	20	59		12	18	1	31
1927	22	10	26	58		12	8	1	21
1928	5	9	26	40		9	12	5	26
1929	15	9	28	52		10	16	3	29
1930	26	5	22	53		13	10	1	24
1931	14	12	30	56		12	17	5	34
1932	10	15	23	48		16	6	5	27
1933	14	10	18	42		21	27	1	49
1934	9	8	26	43		16	17	1	34
1935	10	3	32	45		15	21	5	41
1936	5	4	25	34		24	9	1	34
1937	8	2	22	32		19	2	2	23
1938	8	6	30	44		9	19	2	30
1939	4	5	17	26		6	11	11	28
1940	12	6	30	48		13	14	5	32
1941	5	16	40	61		25	14	5	44
1942	5	8	35	48		11	10	4	25
1943	15	3	43	61		18	14	4	36
1944	10	3	28	41		23	13	2	38
1945	15	5	29	49		19	10	9	38
1946	11	2	42	55		4	9	3	16
1947	9	7	22	38		11	8	1	20
1948	13	8	29	50		20	6	4	30
1949	4	2	45	51		13	17	—	30
1950	16	6	40	62		9	3	3	15
1951	6	3	37	46		4	8	3	15
1952	9	3	33	45		8	13	3	24
1953	10	1	34	45		10	11	5	26
1954	13	3	42	58		7	5	7	19
1955	4	3	34	41		17	13	3	33
1956	16	8	44	68		9	12	7	28
1957	17	3	33	53		17	8	5	30
1958	23	11	35	69		19	2	—	21
1959	4	8	17	29		12	24	5	41
1960	13	—	29	42		27	7	—	34
1961	19	11	38	68		7	10	3	20
1962	20	8	47	75		15	9	7	31
1963	8	4	32	44		7	10	4	21
1964	9	7	50	66		8	4	4	16
1965	10	8	39	57		13	7	7	27
1966	4	9	33	46		14	11	11	36
1967	7	3	38	48		5	13	10	28
1968	6	5	17	28		16	18	6	40
1969	7	2	33	42		21	8	12	41
1970	2	4	43	49		23	10	7	40
1971	8	—	35	43		14	16	2	32
1972	7	6	30	43		10	18	10	38
1973	7	3	28	38		12	13	9	34
1974	16	1	25	42		16	15	9	40
1975	4	—	30	34		5	26	6	37
1976	1	—	25	26		13	10	5	28

Table 3/b

Summer half-yearly frequency of large-scale weather situations of Hungary, days (1877—1976)

Year	*mCw*	*Ae*	*CMw*	Summ	*AF*	*An*	Summ.	*A*	*C*
1877	26	10	1	37	4	20	24	23	1
1878	20	14	5	39	7	20	27	17	2
1879	30	20	7	57	7	20	27	10	3
1880	22	15	12	49	16	18	34	10	6
1881	12	13	4	29	14	20	34	10	4
1882	20	6	12	38	19	18	37	10	4
1883	22	9	3	34	7	19	26	18	4
1884	11	8	10	29	19	24	43	18	5
1885	34	12	7	53	1	19	20	21	3
1886	13	23	11	47	8	16	24	31	3
1887	22	16	5	43	3	26	29	15	4
1888	14	21	6	41	15	17	32	20	4
1889	23	6	11	40	20	22	42	12	—
1890	22	15	12	49	16	18	34	10	6
1891	18	9	4	31	14	19	33	17	7
1892	19	14	6	39	1	14	15	49	—
1893	14	10	7	31	18	15	33	25	1
1894	10	17	10	37	11	18	29	25	2
1895	13	19	6	38	2	10	12	51	2
1896	12	18	16	46	5	29	34	10	3
1897	19	7	10	36	10	24	34	31	8
1898	16	21	7	44	6	18	24	22	4
1899	20	7	11	38	11	19	30	13	3
1900	13	29	11	53	13	18	31	25	1
1901	25	19	4	48	35	27	62	12	1
1902	15	22	11	48	11	6	17	28	2
1903	23	6	9	38	12	12	24	40	3
1904	13	20	7	40	13	17	30	48	3
1905	14	19	9	42	5	24	29	47	2
1906	16	7	10	33	19	12	31	31	2
1907	13	18	14	45	—	7	7	35	—
1908	14	22	8	44	16	13	29	24	3
1909	20	18	1	39	6	29	35	19	1
1910	22	16	9	47	—	32	32	16	6
1911	17	12	5	34	9	31	40	26	1
1912	18	13	7	38	11	31	42	14	1
1913	16	30	11	57	14	29	43	13	4
1914	16	15	6	37	22	22	44	18	3
1915	19	25	8	52	7	29	36	20	3
1916	32	28	2	62	11	16	27	12	2
1917	16	20	2	38	22	11	33	36	1
1918	18	14	12	44	15	17	32	12	—
1919	9	3	10	22	16	21	37	27	1
1920	15	29	—	44	14	35	49	23	1
1921	13	14	9	36	16	41	57	16	—
1922	31	13	7	51	7	26	33	20	2
1923	22	21	8	51	11	6	17	23	1
1924	25	19	7	51	11	18	29	24	3
1925	27	15	5	47	19	18	37	12	3
1926	15	7	13	35	13	20	33	20	5
1927	23	20	3	46	17	26	43	15	—
1928	24	20	10	54	6	14	20	42	1
1929	13	13	3	29	3	38	41	32	—
1930	23	6	10	39	24	18	42	23	2
1931	29	10	3	42	3	24	27	23	1
1932	28	7	2	37	14	6	20	46	5

Year	mCw	Ae	CMw	Summ.	AF	An	Summ.	A	C
1933	14	5	5	24	35	13	48	19	1
1934	26	11	5	42	13	27	40	21	3
1935	22	6	8	36	15	6	21	38	2
1936	22	5	8	35	36	18	54	24	2
1937	26	13	6	45	21	28	49	34	—
1938	12	14	6	32	12	32	44	29	4
1939	24	18	18	60	13	33	46	20	3
1940	19	12	7	38	17	31	48	15	2
1941	27	15	4	46	2	12	14	17	1
1942	21	32	1	54	10	16	26	28	2
1943	9	19	8	36	3	19	22	26	2
1944	25	25	1	51	2	38	40	11	2
1945	23	14	7	44	11	7	18	34	—
1946	6	17	6	29	1	23	24	57	2
1947	3	22	4	29	29	31	60	35	1
1948	11	16	7	34	8	28	36	32	1
1949	11	26	1	38	4	21	25	36	3
1950	22	9	5	36	3	18	21	47	2
1951	13	18	10	41	7	46	53	25	3
1952	21	20	6	47	13	20	33	34	—
1953	12	24	11	47	8	25	33	28	4
1954	23	9	14	46	12	15	27	25	8
1955	11	13	5	29	19	26	45	31	4
1956	15	22	2	39	6	13	19	27	2
1957	14	20	7	41	7	31	38	17	4
1958	18	12	3	33	—	28	28	26	6
1959	7	9	9	25	24	34	58	24	6
1960	21	19	8	48	10	26	36	20	3
1961	14	18	12	44	—	17	17	31	3
1962	4	18	8	30	2	18	20	26	1
1963	15	28	9	52	10	31	41	20	5
1964	13	19	7	39	2	24	26	31	5
1965	29	14	17	60	11	8	19	15	5
1966	22	12	17	51	10	25	35	10	5
1967	21	24	13	58	5	32	37	11	1
1968	28	24	11	63	11	31	42	9	1
1969	24	14	13	51	10	21	31	14	4
1970	37	10	6	53	7	16	23	18	1
1971	19	28	7	54	7	28	35	14	5
1972	9	15	20	44	8	38	46	10	2
1973	18	15	15	48	11	22	33	26	4
1974	18	17	16	51	5	25	30	19	1
1975	20	13	6	39	15	39	54	16	3
1976	18	22	9	49	23	37	60	17	3

Table 4

Trends of the large-scale weather situations

			„I"
Year	y(*zC,As,Aw*)	$= -0{,}090x + 94{,}31$	−0,1
	y(*mCc,AB,CMc*)	$= -0{,}099x + 58{,}69$	−0,184
	y(*mCw,Ae,CMw*)	$= 0{,}104x + 101{,}97$	0,097
	y(*AF,An*)	$= 0{,}158x + 53{,}38$	0,257
	y(*A*)	$= -0{,}075x + 52{,}31$	0,155
	y(*zC,As,Aw,Af,An*)	$= 0{,}067x + 147{,}1$	0,045
	y(*mCc,AB,CMc,mCw, Ae,CMw*)	$= 0{,}005x + 160{,}67$	0,003
Winter half-year	y(*zC,As,Aw*)	$= -0{,}023x + 41{,}62$	
	y(*mCc,AB,CMc*)	$= -0{,}027x + 23{,}16$	
	y(*mCw,Ae,CMw*)	$= 0{,}064x + 61{,}87$	
	y(*AF,An*)	$= 0{,}077x + 24{,}00$	
	y(*A*)	$= -0{,}096x + 29{,}84$	
Summer half-year	y(*zC,As,Aw*)	$= -0{,}063x + 52{,}53$	
	y(*mCc,AB,CMc*)	$= -0{,}073x + 35{,}71$	
	y(*mCw,Ae,CMw*)	$= 0{,}049x + 39{,}87$	
	y(*AF,An*)	$= 0{,}069x + 29{,}91$	
	y(*A*)	$= 0{,}014x + 22{,}84$	

„I": factors of x in the unit of mean annual frequency of the given large-scale weather situations

Table 5

Correlation coefficients between large-scale weather situations

	W	N	S	E	A
W	1,0000	−0,0947	−0,3973	−0,5022	−0,1354
N		1,0000	−0,1561	−0,2669	−0,2350
S			1,0000	−0,0483	−0,4709
E				1,0000	−0,1339
A					1,0000

Table 6

Means of air pressure at sea level in the north region of the Atlantic Ocean (900 mb+)

	Year		Summer half-year		Winter half-year	
	S.	P.	S.	P.	S.	P.
1894	102,4	121,4	110,4	122,6	—	—
95	107,9	117,8	108,8	120,7	105,5	116,4
96	105,1	122,4	109,1	124,0	100,7	118,8
97	105,9	121,2	108,2	122,3	103,4	120,3
98	102,4	119,8	107,0	119,6	101,0	119,9
99	107,0	118,4	111,0	122,4	101,1	115,2
1900	106,8	121,5	109,2	122,4	105,8	117,6
01	106,8	120,3	106,8	121,6	102,8	119,2
02	108,6	119,2	114,8	120,0	106,2	119,5
03	103,8	121,5	111,4	121,6	93,6	120,4
04	103,6	121,2	107,9	122,3	99,9	121,9
05	105,5	121,9	110,4	122,3	100,7	121,0
06	104,7	122,8	110,2	122,2	100,3	125,2
07	104,8	123,0	111,2	121,4	99,1	125,2
08	104,6	123,1	110,4	122,3	99,6	125,2
09	107,0	120,3	110,7	122,2	100,8	119,8

	Year		Summer half-year		Winter half-year	
	S.	P.	S.	P.	S.	P.
1910	105,9	122,7	112,3	122,7	97,2	121,8
11	105,4	121,6	109,9	121,9	104,7	121,0
12	105,9	121,0	112,7	122,6	100,6	117,8
13	102,7	122,3	109,8	123,6	95,1	121,9
14	103,5	122,2	108,7	123,9	98,0	121,1
15	109,8	119,8	113,1	121,4	101,4	119,2
16	107,2	120,8	111,8	121,6	105,4	120,0
17	111,1	121,2	113,0	121,0	107,6	118,0
18	106,2	121,5	110,7	122,6	105,1	121,5
19	107,6	121,5	109,5	123,1	104,7	120,4
1920	102,2	122,2	108,6	121,9	103,1	123,9
1921	103,9	122,4	110,2	122,3	97,0	121,2
22	104,8	122,8	108,8	124,7	98,2	122,0
23	104,3	122,8	109,1	123,1	102,0	120,3
24	105,1	120,2	110,2	122,0	103,0	119,0
25	105,9	121,0	107,0	123,6	97,6	122,4
26	105,6	120,2	108,7	120,3	103,8	116,4
27	106,8	120,7	111,0	121,8	102,0	122,6
28	104,2	121,5	110,2	119,0	102,2	119,4
29	106,3	120,3	111,1	122,2	105,4	119,2
1930	104,4	121,8	109,2	122,0	97,2	121,6
31	106,6	120,6	111,8	121,8	101,6	121,0
32	107,6	121,0	111,4	123,1	102,8	118,0
33	107,1	121,2	109,8	122,7	99,8	120,0
34	104,0	122,0	108,2	121,9	103,4	123,2
35	105,6	123,0	110,6	122,6	101,1	121,0
36	107,4	120,4	110,7	122,3	105,1	117,2
37	104,6	118,8	105,1	121,0	99,2	121,0
38	101,8	122,8	109,5	123,1	101,8	119,8
39	107,6	121,0	111,9	121,1	96,6	121,8
1940	107,9	119,8	109,5	122,0	108,2	117,1
41	109,4	120,3	111,2	121,9	107,6	119,6
42	106,2	119,9	108,6	121,9	104,6	118,3
43	103,5	123,4	108,2	123,8	99,1	120,4
44	105,8	121,5	109,8	121,5	102,0	121,6
45	107,0	119,2	108,8	120,4	101,6	123,1
46	105,2	122,3	107,6	123,9	103,9	117,6
47	108,7	119,0	106,6	122,6	108,0	115,8
48	104,7	120,8	111,0	122,7	103,0	119,2
49	104,8	121,9	111,1	122,0	99,4	120,3
1950	104,4	121,2	107,4	121,9	98,8	121,0
1951	105,0	121,0	111,2	120,4	103,5	120,8
52	109,0	121,0	111,6	122,2	100,6	120,4
53	103,9	121,0	110,8	122,2	105,2	119,8
54	103,9	123,9	110,8	124,3	96,4	122,0
55	109,0	119,0	107,2	122,8	103,1	117,5
56	107,0	121,9	111,6	123,2	107,8	117,4
57	107,0	121,0	114,6	122,6	98,6	119,9
58	109,0	119,9	113,1	121,9	104,2	117,2
59	103,9	121,9	108,7	122,3	101,1	120,8
1960	107,9	119,9	109,9	122,8	103,0	117,8

S.: Stykkisholm
P.: Ponta Delgada

Table 7

Means of air pressure at sea level in the north region of the Pacific Ocean (900 mb +)

	Year		Summer half-year		Winter half-year	
	D.	H.	D.	H.	D.	H.
1917	107,7	117,2	110,3	118,3	—	116,8
1918	107,2	115,7	111,7	115,5	106,5	115,6
1919	106,4	117,2	111,1	116,9	97,0	118,0
1920	108,6	116,5	112,6	116,4	108,2	115,9
1921	106,8	116,8	110,0	116,9	103,1	116,9
1922	107,4	117,2	112,2	117,2	103,4	117,0
1923	105,0	116,1	108,5	116,7	103,7	116,0
1924	106,2	117,4	110,3	117,4	97,5	117,0
1925	104,4	116,6	109,3	117,0	103,3	117,0
1926	93,4	116,8	109,3	116,7	92,7	116,5
1927	106,0	116,6	108,7	116,7	99,4	116,7
1928	102,3	117,4	108,2	116,1	102,4	116,9
1929	104,1	115,8	107,2	116,8	97,9	116,7
1930	108,6	116,1	112,2	116,6	105,2	114,8
1931	105,7	117,1	112,6	116,7	97,4	117,5
1932	107,0	116,6	109,9	117,4	105,5	115,6
1933	109,8	117,5	111,5	118,3	103,8	116,8
1934	104,4	116,8	109,3	116,9	104,4	116,7
1935	108,3	115,9	111,8	116,7	103,1	116,1
1936	106,4	116,0	109,1	116,7	106,0	114,5
1937	108,1	116,4	109,3	117,3	106,2	115,5
1938	102,9	116,0	106,5	116,2	101,9	115,8
1939	106,6	116,4	110,8	116,6	98,7	116,4
1940	102,6	114,7	106,3	115,6	99,6	114,6
1941	103,4	116,5	108,9	116,2	97,1	116,0
1942	105,4	116,5	108,0	116,8	98,0	116,3
1943	106,2	116,8	110,9	117,0	109,2	115,7
1944	106,5	117,4	110,6	118,1	99,6	116,9
1945	106,4	117,1	113,0	116,8	98,5	117,6
1946	106,7	116,7	109,7	117,1	101,0	117,1
1947	105,3	117,1	110,2	117,8	107,3	115,7
1948	105,3	116,7	111,8	116,7	101,1	116,3
1949	107,6	117,4	109,8	118,0	99,7	117,1
1950	109,5	116,5	108,5	117,2	106,5	116,7
1951	109,0	116,3	111,8	116,5	109,9	115,4
1952	105,8	117,3	114,2	117,5	104,8	117,0
1953	104,5	117,5	110,8	117,7	97,9	116,9
1954	108,8	116,7	112,5	117,0	103,3	116,7
1955	108,1	116,8	109,5	117,7	102,3	116,7
1956	109,2	116,3	109,3	117,2	109,7	115,3
1957	107,9	116,0	111,0	116,5	108,5	115,7
1958	104,8	116,3	108,5	116,8	100,3	115,5
1959	108,4	116,2	112,7	116,0	105,0	116,2
1960	106,7	116,7	111,7	116,7	101,8	116,5

D.: Dutch Harbor
H.: Honolulu

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DATAS CONCERNING THE SPHERE OF AGROMETEOROLOGICAL INFORMATIONS OBTAINABLE FROM THE EXAMINATION OF THE STATISTICAL STRUCTURE OF LOCAL TEMPERATURE EXTREMITIES

by

Cs. Károssy

Adatok a napi hőmérsékleti szélsőségek hazai statisztikai szerkezetének vizsgálatából nyerhető agrometeorológiai információ kérdéséhez. A napi szélső hőmérsékletek együttes gyakorisági eloszlása statisztikai szerkezetének meghatározása mellett feladatunknak tekintettük a napi szélső hőmérsékletek statisztikai paramétereinek vizsgálatából nyerhető agrometeorológiai információ feltárását. Az eloszlások áttekintését megkönnyítő kétdimenziós típusnap rendszerezés megalkotásával, a típusnapok havi és évi értékeinek közlésével új klimatológiai jellemzőket kívántunk megismertetni.

A táblázatok és ábrák tartalmának értelmezése és gyakorlati hasznosítása agro- és bioklimatológiai kutatásokban, valamint a korszerű mezőgazdasági gyakorlatban valósulhat meg.

Beside the exploration and determination of the statistical structure of collective distribution of daily temperature extremities it was considered an objective the exploration of agrometeorological information obtainable from the examination of statistical parameters of daily extreme temperatures as well.

It was aimed to acquaint with the readers new climatological informations obtained from the creation of a two-dimensional typeday catalogueing which facilitates the survey of distributions, with the publication of monthly and yearly values of typedays.

The interpretation of the datas appearing on the tables and figures, their application in practice can be realized in agro- and biometeorological researches as well as in a modern agricultural practice.

Introduction

In more than twenty years no work of importance has dealt with a detailed examination of daily temperature extremities in Hungary. Works concerning the characteristics of the distribution of daily minimum and maximum temperatures were published only recently [1, 2, 3, 4].

Up to now no local or foreign work has dealt yet with the joint observation of the distribution frequency of daily temperature extremities in a two-dimensional statistic field.

The aim of this work examining the local structure of collective distribution frequency was to determine the two-dimensional distribution frequency of the two temperature characteristics, to reveal its statistical structure and to display the — from an agrometeorological point of view utilisable results on tables and diagrams.

With the help of the two-dimensional statistic methods [5] applied in this work hitherto unknown information could be revealed about the collective distribution of above-mentioned closely related two climate factors.

An analysis applying this method, of the element groups of the two temperature characteristics, offers a considerable help and directly utilisable informations especially in agro- and biometeorological researches [6, 7].

On the basis of the results of our researches more exact and ambigous extreme temperature climate limits and characteristics can be determined, which are necessary to the cultivation of different plants, and to the application of modern agrotechnical processes.

The Occurrance of Theme in Hungarian and in Foreign Special Literature

At the beginning of the fifties *Bacsó* analysed the local distribution of daily temperature extremities, the geographic structure of extreme temperature treshold days [8, 9, 10, 11].

At the beginning of the sixties the frequency distribution of daily maximum and minimum temperatures was discussed by *M. Rákóczi* and *Hajósy* [12, 13].

From the beginning of the seventies a detailed and differently centred analysis has been made of the frequency distribution of daily temperature extremities and that of their difference given by daily temperature oscillations by *Károssy* and *Kiss* [14, 15, 16, 17, 18].

The collective analysis of the different climate factors has recently made its appearance in the Hungarian as well as in the foreign special literature [17, 18, 19, 20, 21, 22, 23].

In the above-quoted works with the collective statistical analysis of closely related climate elements, the intricate, interrelating system of relationships of hitherto independently, separately treated climate factors can be exposed.

Analytical Methods and Datas

The definitions, functions and formulas applied for two-dimensional conditional distributions were utilised [5] in the course of the analysis.

To reveal the statistical structure of daily temperature extremities, the daily maximum and minimum temperature datas of sixty years, observed by eight Hungarian meteorological satations (Mosonmagyaróvár, Keszthely, Pécs, Budapest, Kalocsa, Kecskemét, Szeged and Debrecen) were utilised, during the period of 1901—1960/64.

Calculations necessary to this work were completed by a computer type R 40 which is in the possession of JATE (József Attila University of Sciences and Arts) with a suitable transformation and replay of program OSIRIS III. Datas were obtained by copying the datas recorded on magnetic tapes of the Meteorological Office.

With the obtained datas the monthly and yearly contingency charts could be drawn representing the collective frequency distribution with 1° temperature intervals.

With the help of contingency charts the figures of the two-dimensional frequency distribution fields pertinent to the above-mentioned stations can be drawn *(Figures 1—13)*.

From the empiric frequency distributions the relative frequencies, of the days given by a new, uniform codificating method introduced on *Figure 14*, of the occurrance of extreme temperature treshold days pertinent to the given values, as well as the place and time factors of daily temperature oscillations could be determined *(Tables 1—19)*.

To the analysis of the collective frequencies of extreme temperature treshold days pertinent to given temperatures the above-mentioned standardization and designation system was elaborated.

From the frequencies of two-dimensional collective distributions the statistical parameters of the two temperature characteristics as well as the values of obliquity and distorsion, signifying third and fourth degree momentums, were determined. The normality analysis of the empirical limit distributions was completed by the χ^2 proving method. It was tried to simplify the normality analysis of the distributional surface with the help of different fluctuation parameters obtainable from the collective distributional fields.

With the yearly and monthly regression straights of the two temperature characteristics as well as with the analysis of the correlating coefficients the change of the joint conditions of the two, closely related climatic elements, and the nature of their stohastic relation were observed [24].

To analyse the connection between the two temperature characteristics and the meteorological positions the datas were classified according to the respective days being shiny, cloudy, windy or calm during the 1964—73 ten year long period in Szeged as well as these datas were examined on the basis of collective frequencies grouped according to the large scale weather situations with the *Péczely* method [14, 15, 24].

Evaluation of Analytical Results

It can be stated from an examination of the frequency fields of collective empiric frequency distributions of the daily temperature extremities that the collective frequency fields occupy according to the yearly temperature proceeding different areas of the expounded distribution field. The inner bodies of the distribution fields of greater relative incidence with the displacement of the whole distribution field are shifted into different temperature territories. During the winter months along the $y=x$ straight as an axis the distribution fields are more elongated and they concentrate with greater incidence values. The maximal densities with an occurance of 1,5 and 2,0% collective frequencies are found more or less in the same temperature territories. This means that during the winter months in the different areas of our country approximatively the same incidence of collective distribution of daily extreme temperatures can be expected to occur in the same temperature territories. During the spring, summer and autumn months the inner probability fields of collective incidences with greater relative occurrence are manifold cut, they shift into a different temperature interval at a different meteorological station. This is first of all the characteristic of the summer and early autumn periods. This means, that in our country there are significant differences in the daily extreme temperature values, and it is especially apparent in the probability fields of less than 5% relative incidence values. These extreme temperature differences of collective (frequencies) occurence frequency values must be considered in the meteorological practice especially in the cultivation of plants which are sensitive to daily temperature extremities. Above-stated facts are underlined by the fact that the absolute probability territories of collective distribution fields greatly differ according to month as well as station. There are significant differences during the summer, autumn and especially spring months. The differences of distribution fields can be explained with the great dispersion of the daily temperature extremities, and with a significant extension of these dispersions during the year (summer). The greatest dispersions experienced during the summer months most probable are due to the greater radiation and consequently greater eradiation of the summer which are decesive factors in forming the daily temperature extremities [17]. Because of the density of datas above-mentioned great differences are less shown on the yearly distribution fields of collective frequency distribution of daily temperature extremities, the differences in the form and moduses of distribution fields refer however to the moderating effect of Atlantic climate which is more prevalent in the North-West part of the country, to the daily temperature extremities. The stronger predominance of Continental climate effects on the Great Hungarian Plain is displayed with the greater largeness of the yearly distribution fields and their displacement into the direction of more extreme temperature territories.

The above-mentioned characteristics of collective distribution of daily temperature extremities are, first of all, apparent in given temperature conditions, with the declaration and examination of the number of treshold days which can be utilised agrometeorological and bioclimatological researches as well as in the agricultural producing process. Instead of the extreme temperature treshold day standardization prevalent in the climatological practice, an improved variation, a uniform two-dimensional temperature standardization developped and suggested *(Fig. 14)* here makes possible the grouping into given temperature territories of the collective incidence of the daily maximum and minimum temperatures occuring in any climatic territory so that the data are grouped according to daily temperature oscillations as well. The here suggested logical system of designations and denominations of the two-dimensional extreme temperature standard days are in complete consistency with the earlier prevalent treshold day standardization, though it was in many ways wanting and contradictory, which shortcomings are eliminated now.

The structure of the two-dimensional treshold day standardization introduced on figure 14 is explained as follows: To design daily maximum and minimum temperatures to superiour to 0 °C capitals, those inferiour to 0 °C the small letters were introduced. At the application of letters the one designating the daily maximum temperature was placed first at all times. The letters codifying daily maximum and minimum temperatures with 10 °C intervals are distributed on both axes in a positive and negative direction from the origin with 10 °C spaces inbetween. In this way a codificating system determined by two letters is obtained which groups the aboveintroduced density intervals of the two-dimensional extreme temperature statistic field with combination of the successive letters and capitals of the alphabet.

The codifiying method introduced on figure 14 gives the standardization of collective frequency of daily temperature extremities in this country. A consequent expanding of the now introduced system of codification makes possible the two-dimensional grouping of daily temperature extremities occuring on any climatic territory of the Earth.

An earlier standardization of extreme temperature treshold days made possible a more detailed (5 °C) grouping (e.g. summer day, heat day) in certain temperature intervals (25 °C, 35 °C). In order to ensure a more detailed grouping in the codificating system an upper and lower comma were introduced to designate the 5 °C treshold values within the 10 °C intervals while applying at the same time the letter for the 10 °C interval of a given variable. This means that the maximum temperatures belonging to the 25 °C and 30 °C interval are designated according to the 10 °C distribution "C" and an upper comma. Consequently a day with a maximum temperature of 26 °C and a minimum temperature of 7 °C is designated "C' A".

On *Table 1* the collective two-dimensional frequencies of yearly average values of the analysed meteorological stations are displayed grouped according to above-mentioned coding types. The heading of the charts represent the examined stations (Mosonmagyaróvár, Keszthely, Pécs, Budapest, Kalocsa, Kecskemét, Szeged, Debrecen). There are significant differences in the yearly avarage occurrence of the different collective extreme temperature types at the various stations. Differences can be as great as 20—30% avarage.

The standardization introduced on *Fig.14* and *Table 1* can be improved by taking into account the measure of daily temperature changes. If the daily temperature oscillations are distributed into three groups (I — temperature oscillation) $I<5°=$ $=$small daily temperature oscillation, $5°<I<15°$ (medium daily temperature oscillation) $I>15°$ (great daily temperature oscillation), these temperature oscillation categories cut parallel fields with the $y=x$ straight as an axis. In this way the yearly collective extreme temperature treshold day types given on *Tables 2—4* and grouped according to daily temperature oscillation categories are obtained, as well as the values of collective, two-dimensional treshold day types pertinent to the various stations, which values are grouped on *Tables 5—16* with daily, monthly oscillations.

The values on the charts of two-dimensional extreme temperature frequencies are expressed in days which show the local distribution of extreme temperature collective statistical structure. The predominance of Continental effects on the Great Hungarian Plain can be observed from the low values of small daily temperature oscillations at Kecskemét and Debrecen (68,16 and 38,00 days), while the Atlantic climatic effect is more predominant at Mosonmagyaróvár (91,03 days). On the other hand, the number of days with great temperature oscillation is the highest on the Great Hungarian Plain (Kecskemét 47,29 and Debrecen 89,60 days), while the avarege values were 12,73 at Keszthely and 20,00 at Kalocsa.

The avarage yearly values grouped according to the two-dimensional extreme values treshold day temperature oscillations significantly differ from each other in every type at the various stations. The difference between some frequencies can be in case of a few types one or twofold only, in the case of most types three or four times as much and in many cases there can be a tenfold difference even *(Tables 2, 3, 4)*.

The avarage values of monthly collective two-dimensional treshold day types-appearing on *Tables 5—16* show the following main characteristics: During the winter months maximal values occur at small temperature oscillation in types "aa", "Aa" and "AA", at medium temperature oscillation days in types "Aa", at great daily temperature oscillations in types "Aa", "Ab" and "Ba". During spring months corresponding to the increasing temperature the collective daily extreme temperature frequencies occur in the greatest number at small oscillation days in types "AA" and "BB", at medium oscillation days at types "BA" and "CB", at great oscillation days in types "Ba", "BA", "Ca". and "CA". During the summer months the greatest frequencies can be found during days with small temperature oscillation in types "BB", during days with medium oscillation in types "CB" and "CB", during days with great temperature ocillation in types "C'B". During winter months corresponding to the decreasing daily temperature the types characterising spring months occur with maximal values.

The monthly avarage days of the examined stations, corresponding to the daily extreme temperatures of small, medium and great temperature oscillations are shown on *Tables 17, 18* and *19.* The figures and the tables make apparent that the frequency of days with small temperature oscillations is highest during the winter months. At Budapest, Keszthely and Mosonmagyaróvár more than half of the month's days belong to this type. Significantly less such days occur at Kalocsa and in Debrecen (11,78 and 11,42 days). During the spring and the summer months the avarage number of days with small temperature oscillation significantly decreases. During July and August there are 0,22 such days in Debrecen and 0,40 at Kecskemét. The maximal incidence of days with medium temperature oscillation vary from station to station during the spring months (March, May) in July in Budapest, it appears with values from 23—26 days. The maximal incidence of days with great temperature oscillation appears during the summer months. In July with an avarage of 13,85 days at Debrecen and with 4,14 days at Keszthely in August (*Tables 17—19)*.

Grouping the daily extreme temperatures of the examined stations according to the size of oscillations unambigously shows the previously stated role of Continental and Atlantic effects in the local occurrence of extreme temperatures [15, 24].

Present work does not aim to discuss further information appearing on Tables 1—19. With the publication of obtained datas it was wished to be able to offer a contribution to a detailed extreme temperature analysis which is becoming more and more important in the agrometeorological and bioclimatological researches as well as some datas which can be utilised in the agricultural practice.

It is especially important to apply and to disperse the suggested treshold day standardization, the consideration of informations appearing on the charts in the cultivation of plants which are sensitive to temperature effects. In the case of maize, for example, the occurrance of treshold temperature treshold days of types "BB", "CB" and "CC", in the case of tomatoes and paprika types "CB" and "CC" provide the most favourable agroclimatological condition to the growing and development of these plants [25].

The different classification applied in agrimatology [26] are completed and mode more exact [27] by the uniform, two-dimensional standardization and data processing introduced in this work.

From an analysis of further statistical parameters defined to the examination of collective distribution of daily temperature extremities certain statements can be drawn which correspond to previous research results though they elucidate the problem of collective distributions to a greater extent [5].

On the basis of χ^2 proof applied to the values of density projections of collective distribution fields it can be stated that both monthly and yearly collective distribution fields are best approached with the help of the two-dimensional normal disstribution. The one year long collective distribution field, because of the cumulation of values of the winter and summer months, can be described with a combined, two-dimensional normal distribution with two moduses, while the one month long distribution fields can be described with a two-dimensional normal distribution with parameters of monthly varying peak and obliquity. Corresponding to the two-dimensional normal distribution the frequency fields of collective distributions, because of the mutual, from above limited condition of the two temperature characteristics, can theoretically be circumscribed with ellipses expanding in a various degree along the straight $y=x$ as an axis. The theoretically defined elliptic distribution fields are not filled in with the actual distribution fields — since sixty years is a too short period for a thorough examination of extreme temperatures. In case of longer temperature lines the difference between the two distribution fields would be less apperent. The geometrical regressive straights derived from the absolute values of extreme temperatures and the calculated actual regression straights do not correspond because of the inner distorsion of the distribution fields. From the difference between the coeffcients of the two reession straights the degree of adherence of the distribution surfaces to the normal distribution surface can be deducted. The quick and simple procedure suggested to examine the normality and adherence of distribution surfaces compares assumedly uniformly distributed theoretic distribution fields and assumedly normally distributed empiric distribution fields so it can be utilised in defining the degree of normality only in an informal way. From the calculations within the scope of this work it can be concluded that on the basis of the χ^2 proof there are no significant differences between the normal distribution and the collective extreme temperature distribution fields.

Determination and being aware of the absolute extreme values of the collective distribution fields along with the normality of collective distribution fields make possible to from the outlines of the collective extreme temperature frequency fields without the long and tedious dimensioning of the complete set of datas. Above-mentioned method allows furthermore the extension of parameters determined from a smaller set of datas to a longer period of time at meteorological stations that do not possess longer observation series, as well as an approaching determination of climatologically obtainable collective frequency distributions of the two temperature characteristics and a forming of collective distribution fields with a certain error.

To draw a theoretically determinable distribution field with the above-mentioned method, it would be necessary to supply and to publish parameters MAX_{min} and MIN_{max}, that is the yearly and monthly lowest maximum and highest minimum values which have not been used in meteorological publication of data yet.

It can be concluded from the yearly and monthly lines of regression straights showing the degree of mutual condition of the two temperature characteristics that the daily maximum temperatures influence to a greater extent daily minimum temperatures during winter and vice versa, — daily minimum temperatures more strongly determine the maximum temperature of the same day during winter than during summer. During the spring, summer and autumn months the reason for the decreasingly close conditional relation unequivocally shows the effects of radiation factors.

The same observation is reflected by the correlation coefficients which express the closeness of the relation of the two temperature characteristics. The relations which appears positive positive during the whole year, is closer during winter months than during summer.

The decrease of closeness of relation during the summer months on one hand can be explained with the effect of advection factors which play a more significant role during that time and with the fact that the surface eradiates to a greater extent as a consequence of a stronger radiation and warming up, on the other hand.

Above statements are underlined with more detailed datas by the statistical parameters of collective frequency distribution of daily temperature extremities examined for ten day long periods. With the help of parameters for periods of ten days the singularities of the line of the two temperature characteristics were demonstrated, which singularities appear only during certain periods [15]. With the determination of singular dates and with the analysis of tis characteristics it was wished to offer informations which can be utilised in agrometeorological forecasts.

With a tangential examination of the relation between the large scale weather situation and the collective daily extreme temperatures it was concluded that anticyclonic situation which cause fair weather *(Ae, A* give rise to essentially greater temperature oscillations than cyclonic situations which can be characterised with a cloudy sky *(mCc, CMw)*, or *AW* anticyclonic situation. The greatest temperature oscillations ($I > 15$ °C) are created by situation *A* and *An* on fair advectional days in October, by situation *As* and *Ae* on days without advection [14].

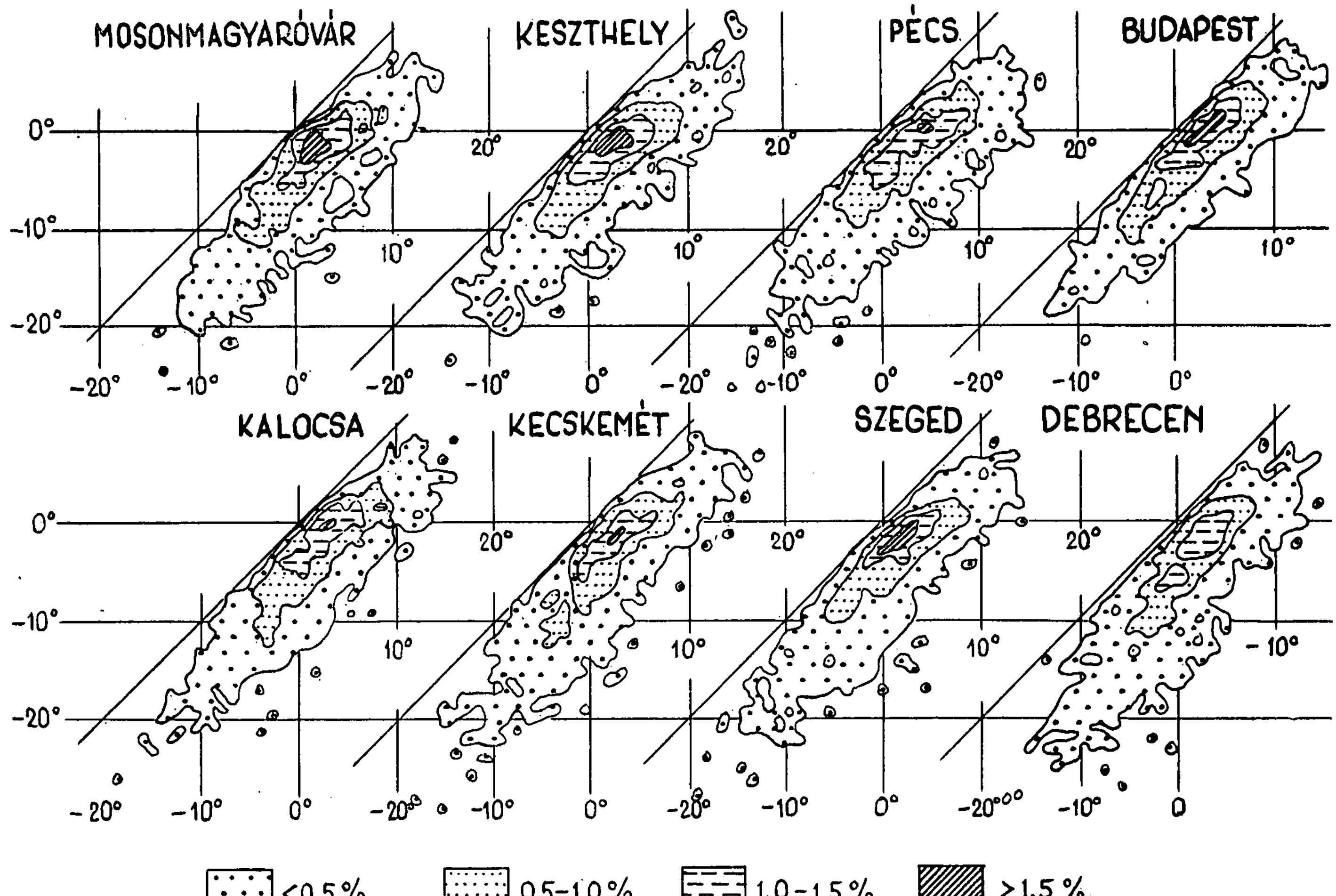

Fig. 1. The collective two-dimensional distribution field of the daily temperature extremities by 1 °C and by stations, January

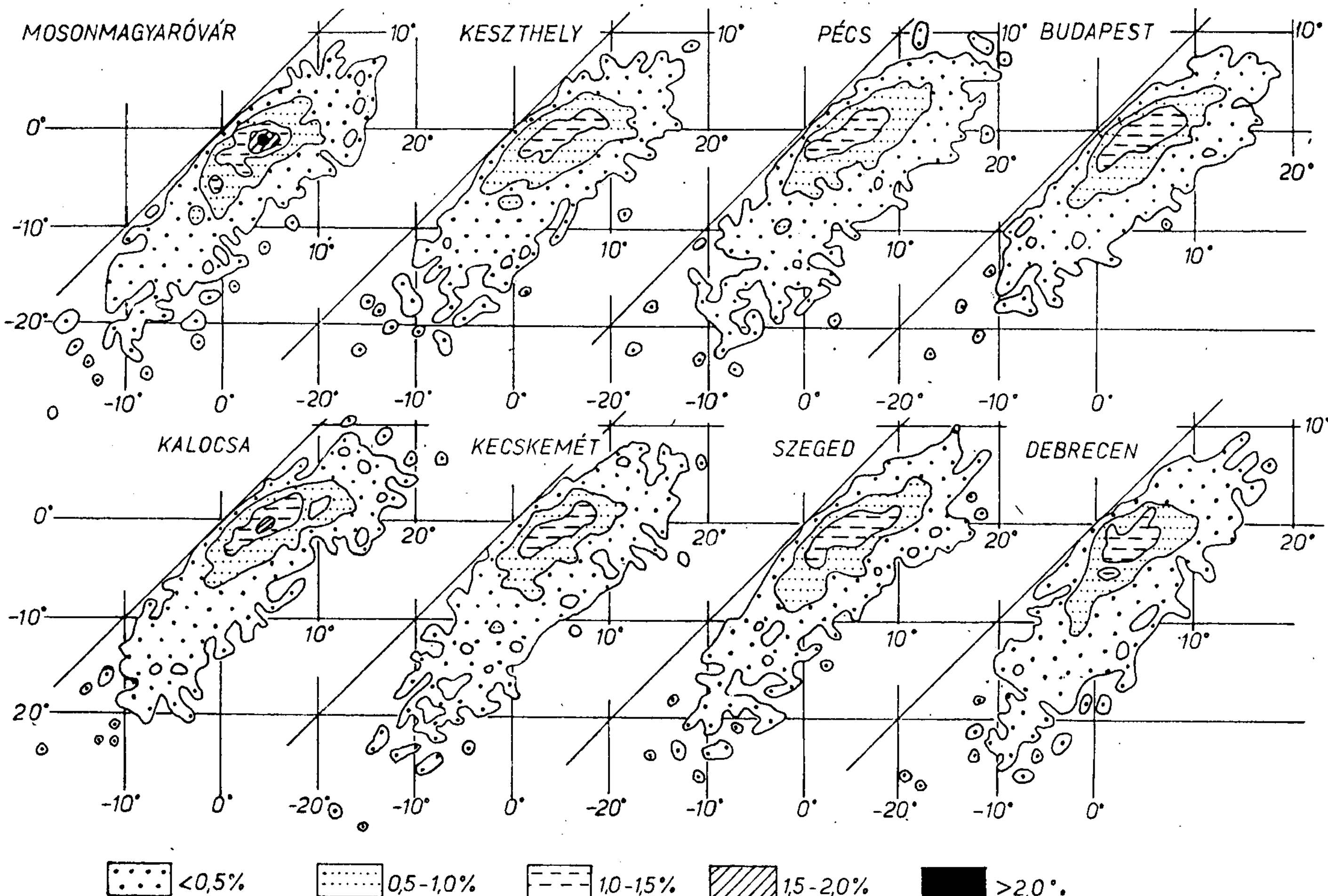

Fig. 2. The collective two-dimensional distribution field of the daily temperature extremities by 1° C and by stations, February

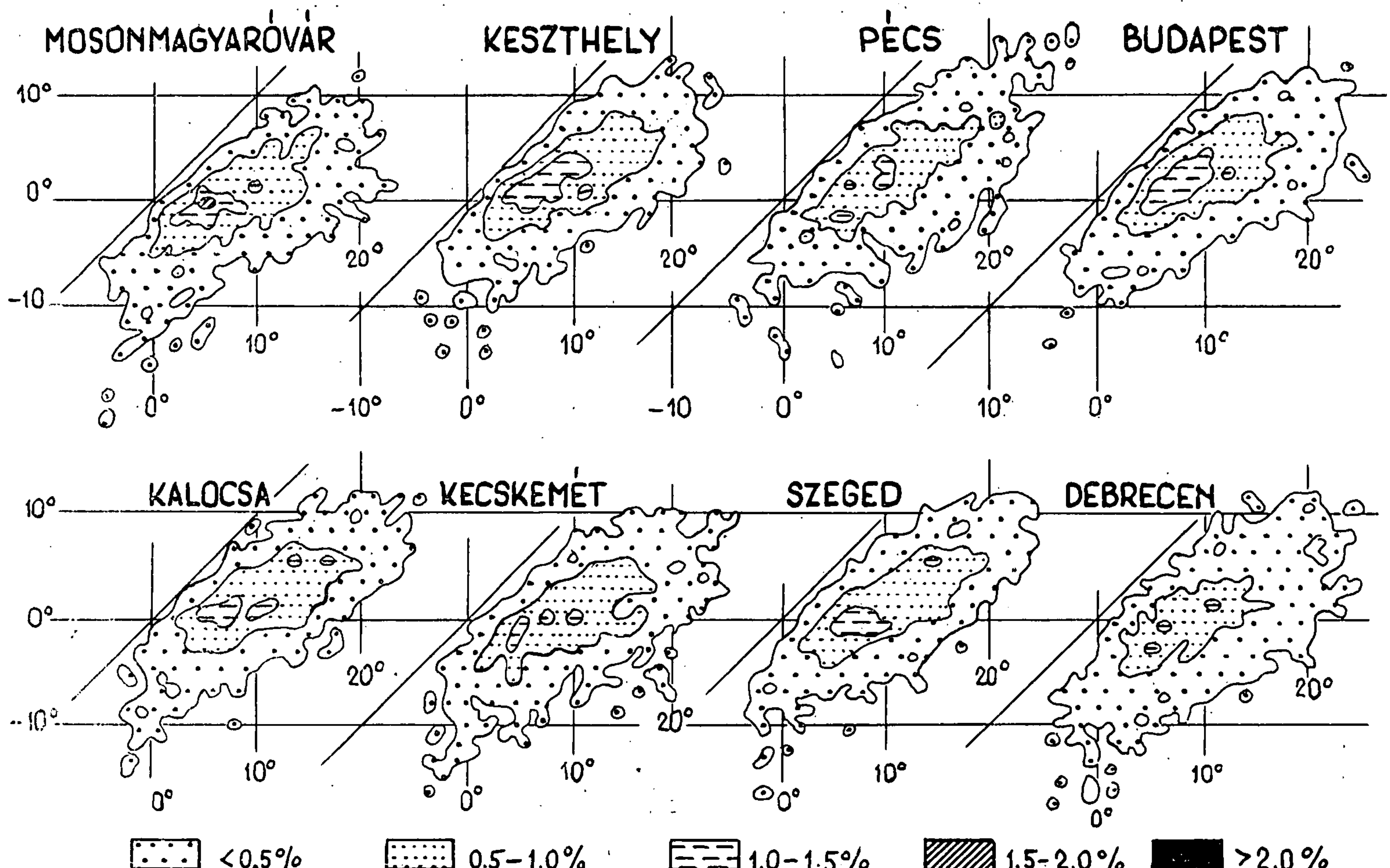

Fig. 3. The collective two-dimensional distribution field of the daily temperature extremities by 1 °C and by stations, March

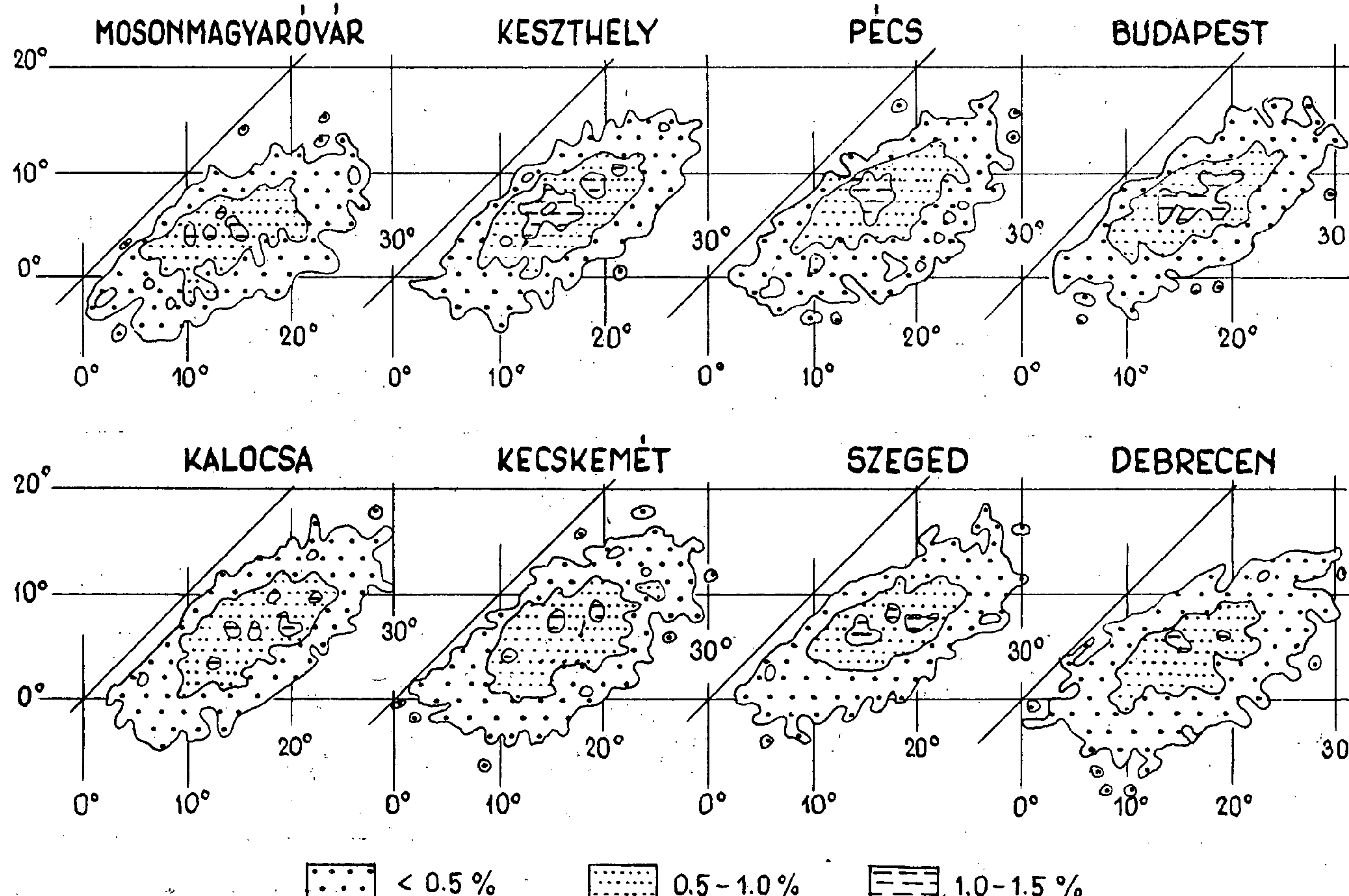

Fig. 4. The collective two-dimensional distribution field of the daily temperature extremities by 1 °C and by stations, April

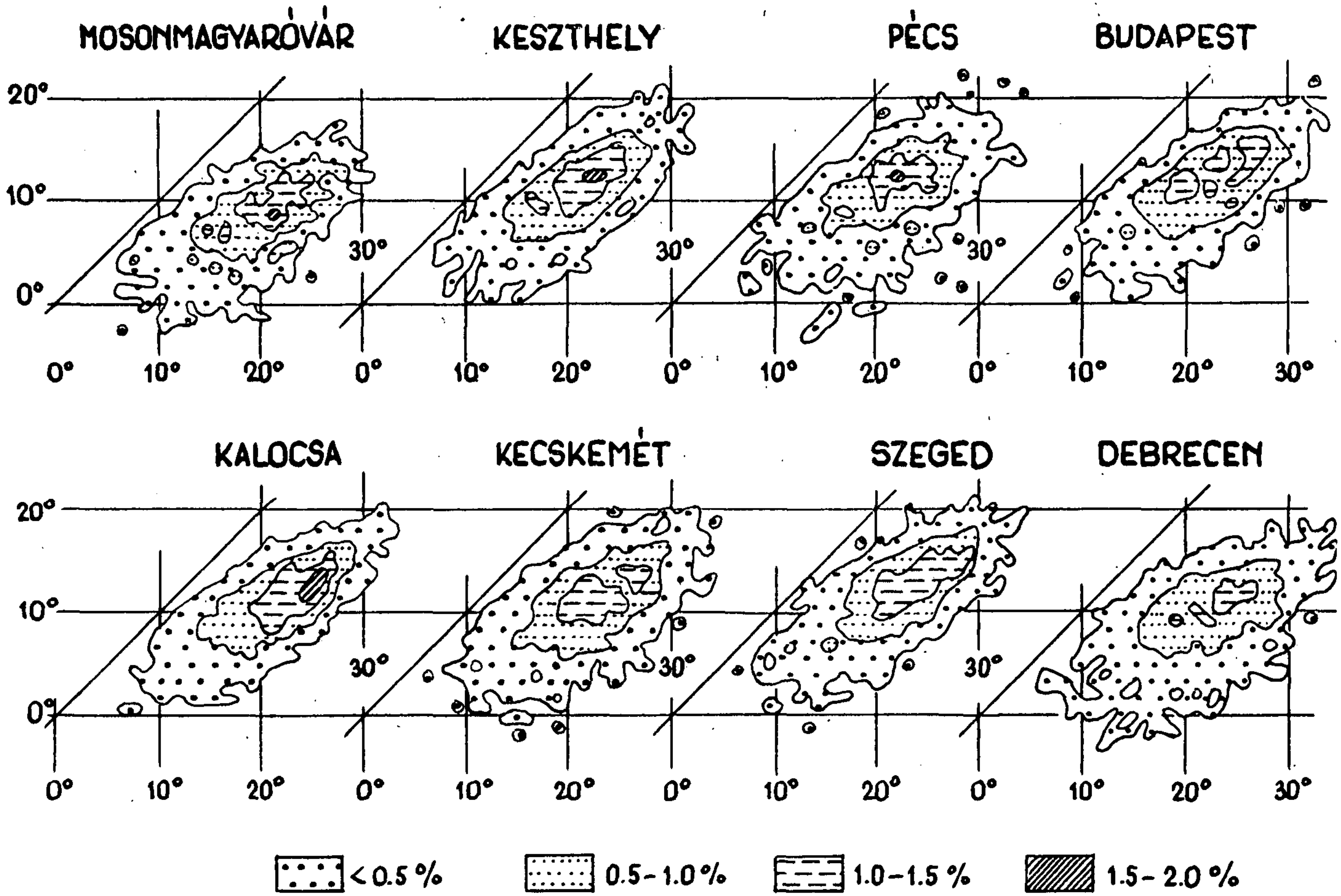

Fig. 5. The collective two-dimensional distribution field of the daily temperature extremities by 1 °C and by stations, May

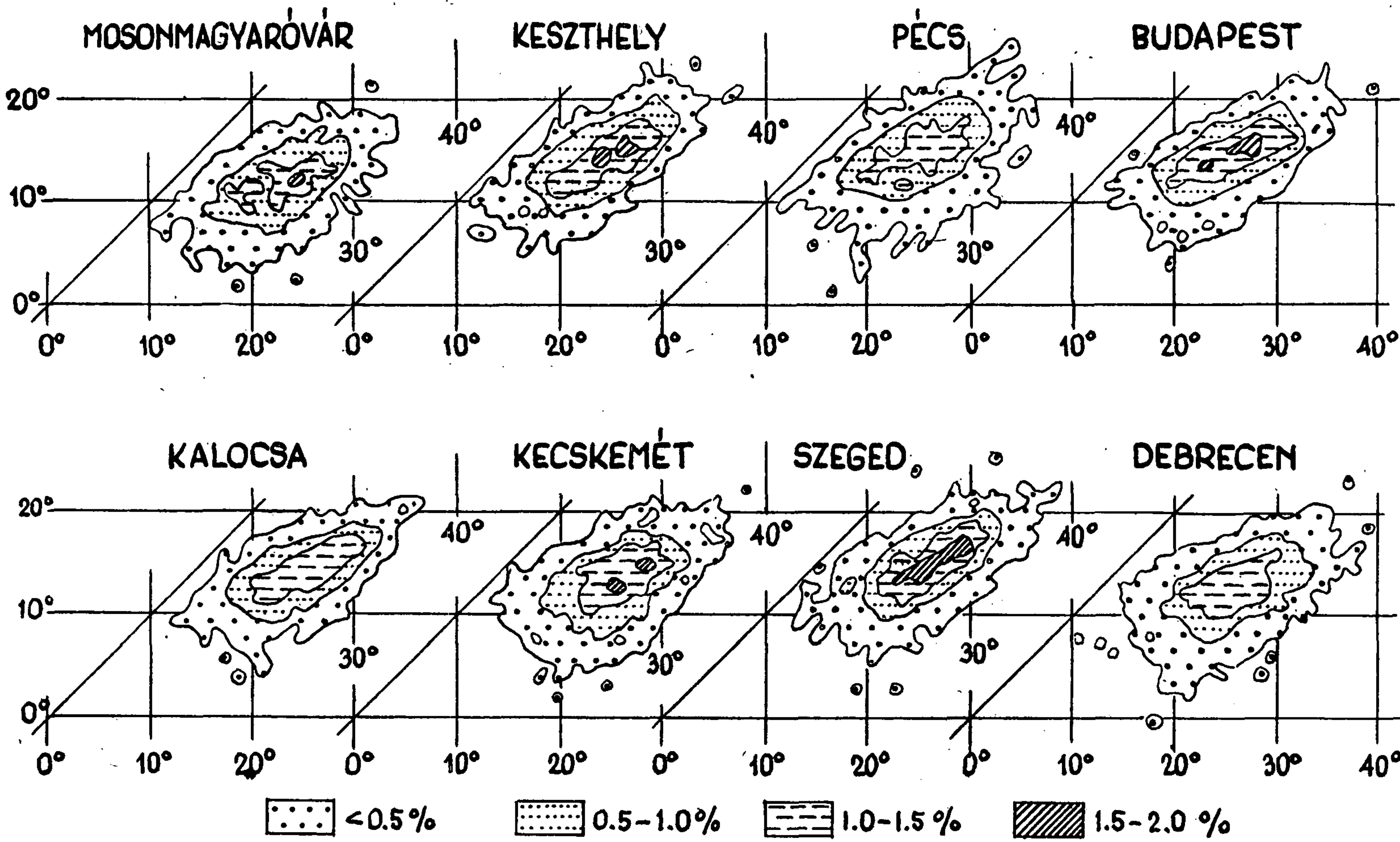

Fig. 6. The collective two-dimensional distribution field of the daily temperature extremities by 1 °C and by stations, June

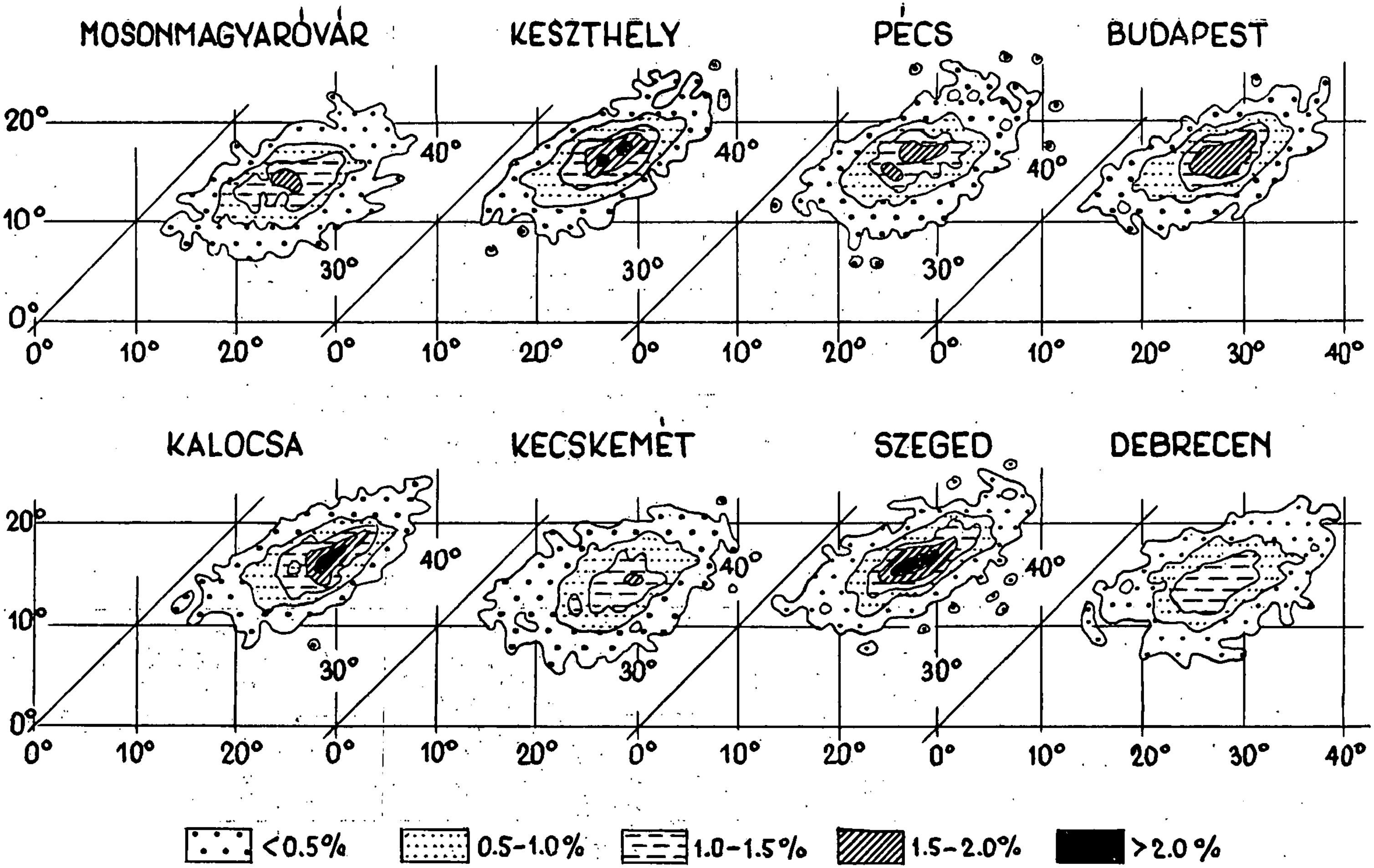

Fig. 7. The collective two-dimensional distribution field of the daily temperature extremities by 1 °C and by stations, July

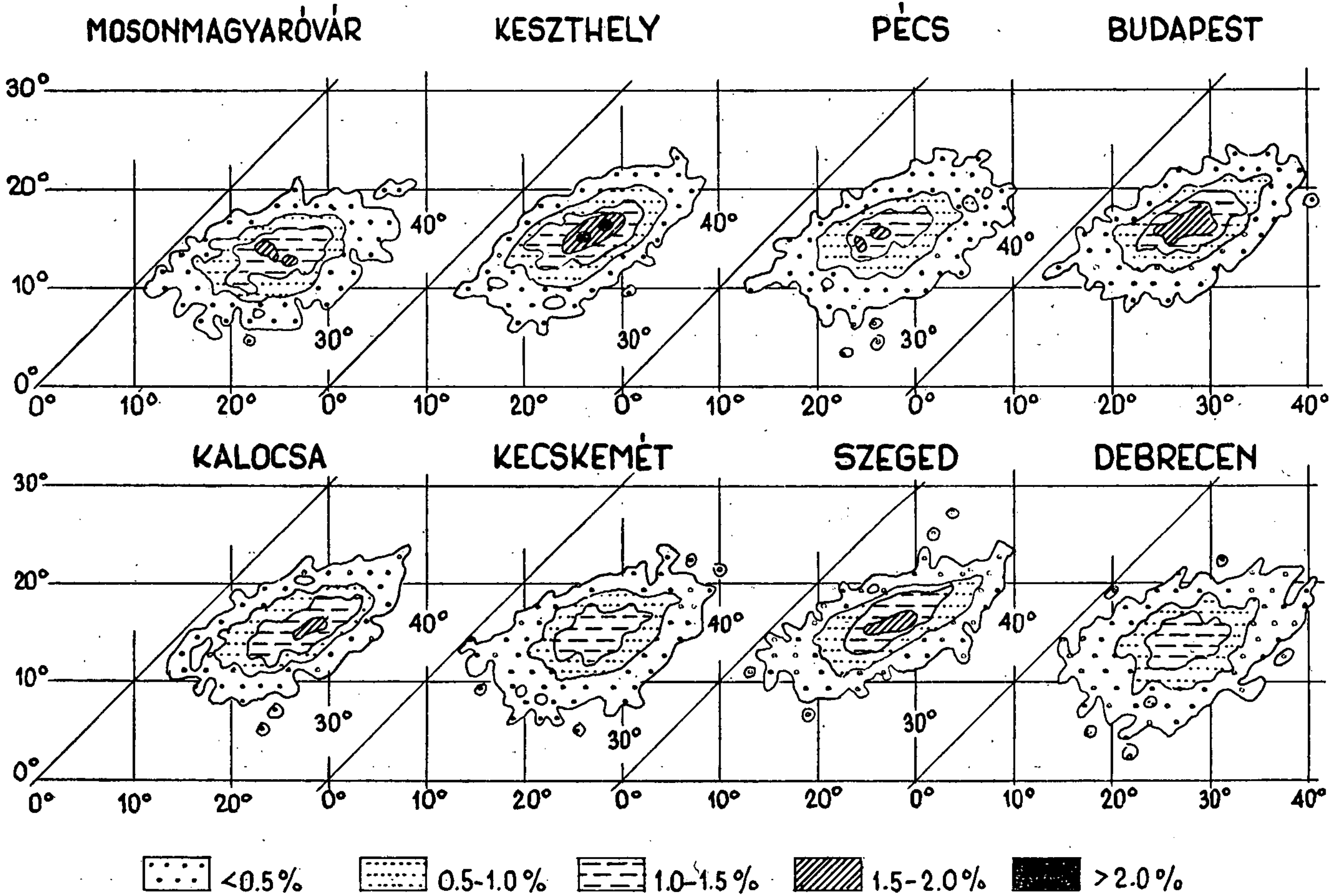

Fig. 8. The collective two-dimensional distribution field of the daily temperature extremities by 1 °C and by stations, August

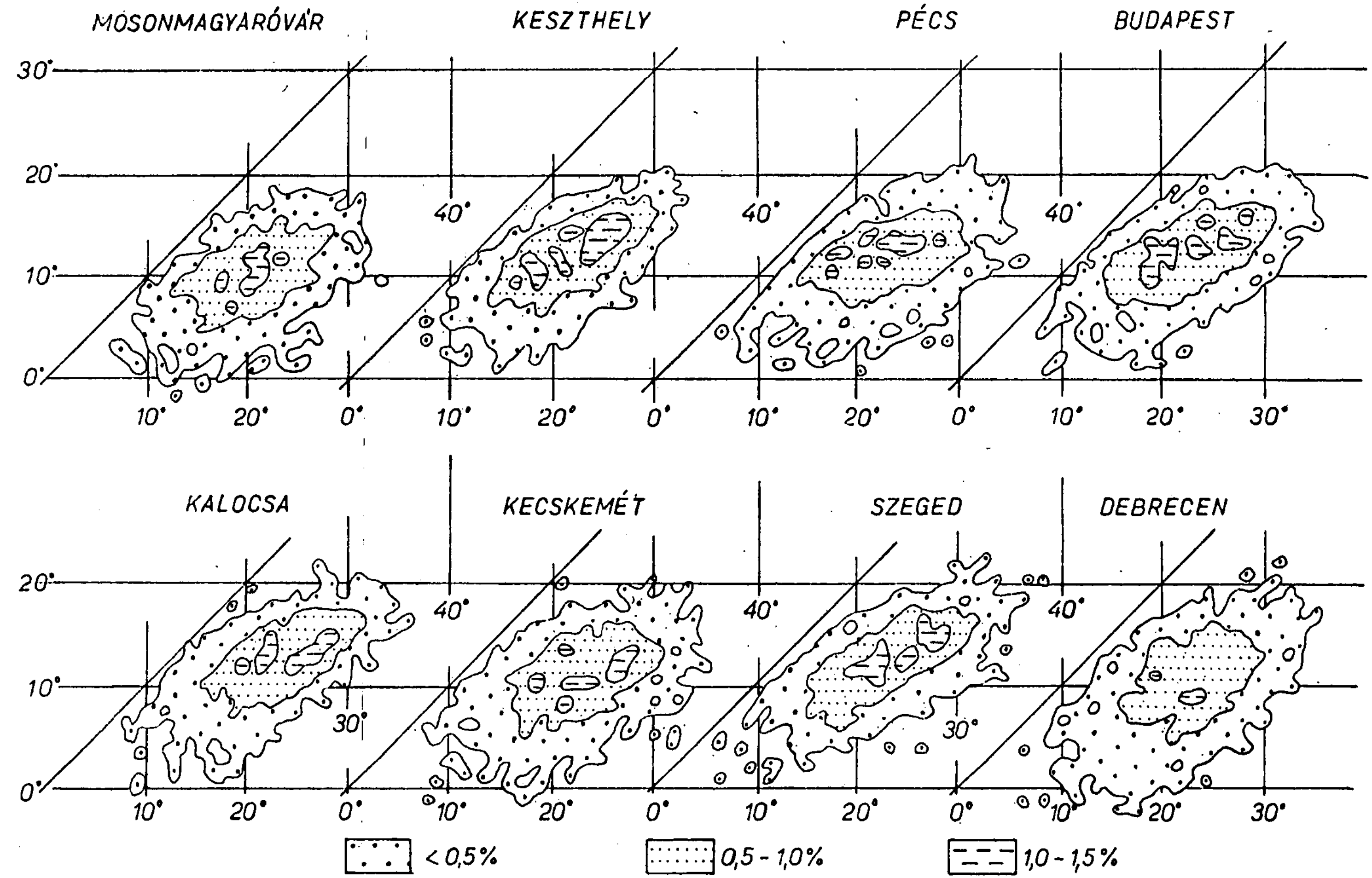

Fig. 9. The collective two-dimensional distribution field of the daily temperature extremities by 1 °C and by stations, September

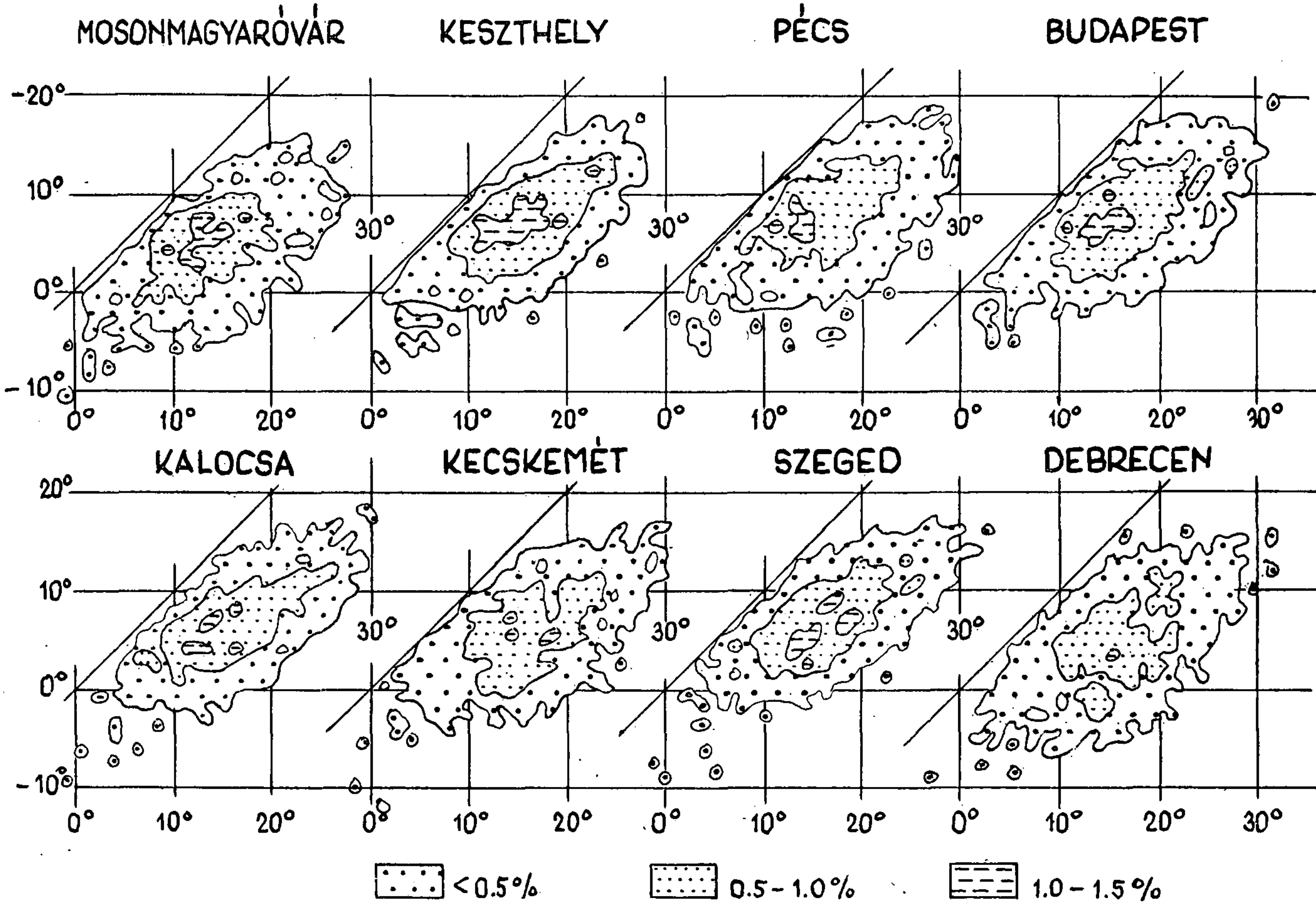

Fig. 10. The collective two-dimensional distribution field of the daily temperature extremities by 1 °C and by stations, October

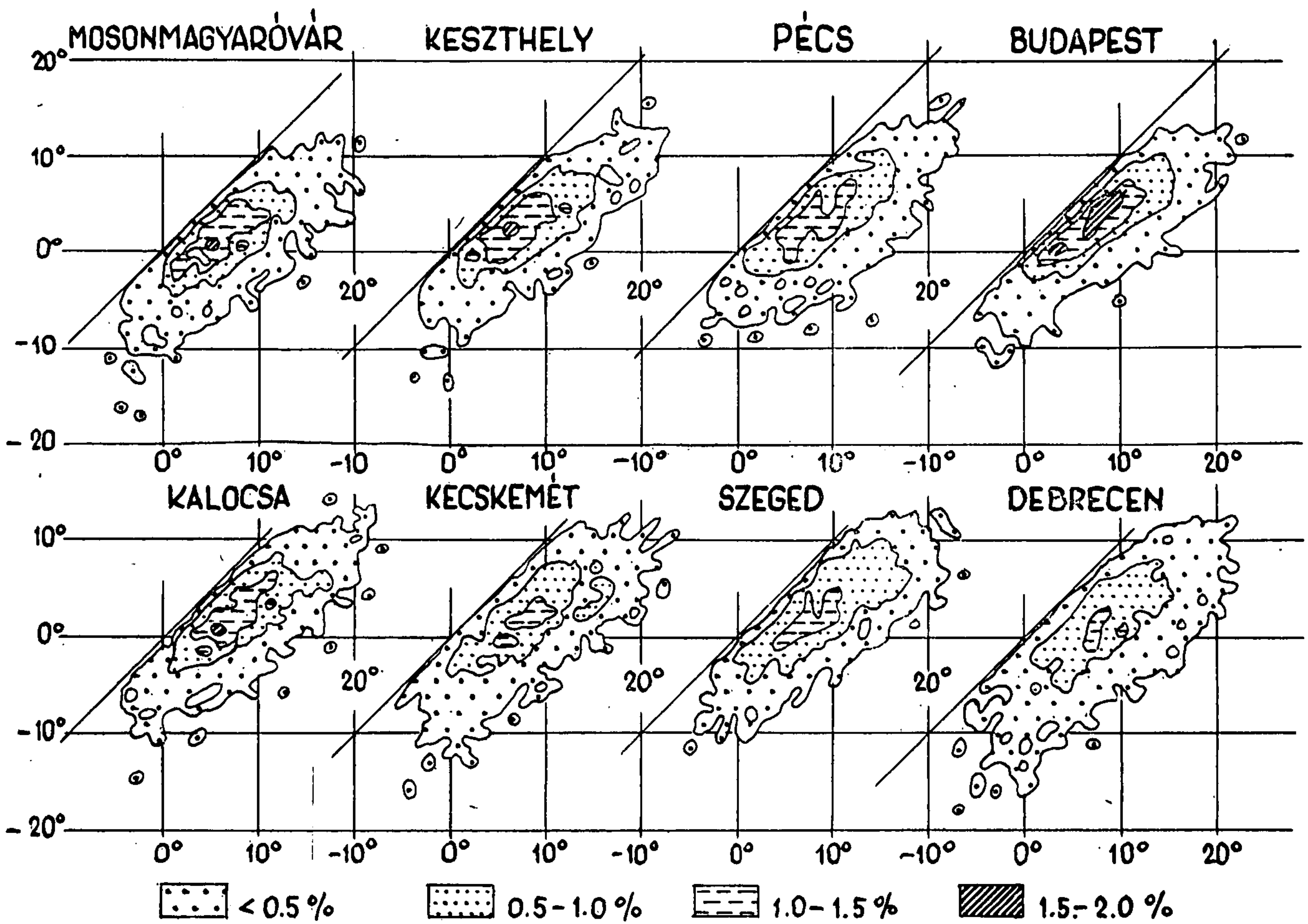

Fig. 11. The collective two-dimensional distribution field of the dail temperature extremities by 1 °C and by stations, November

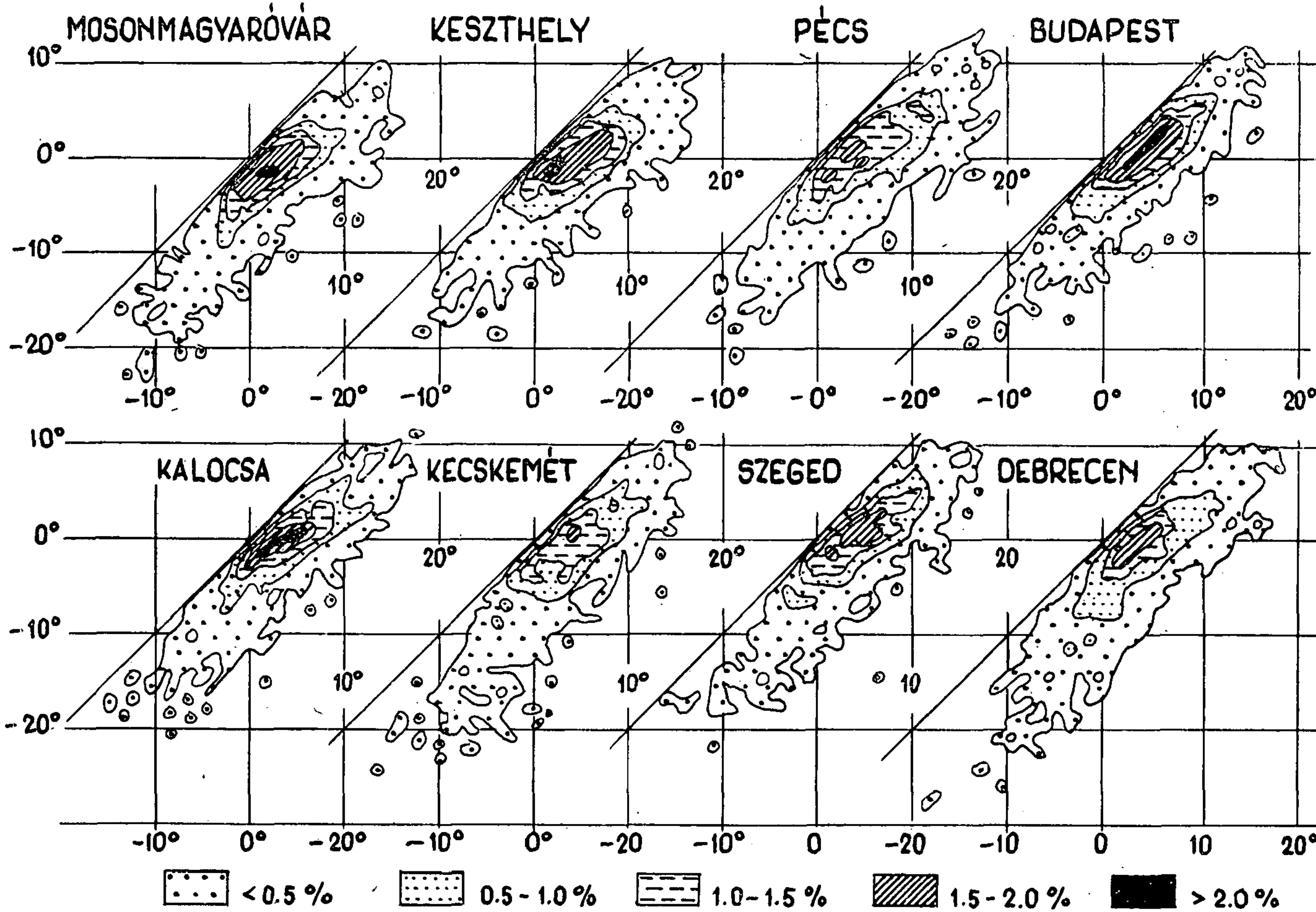

Fig. 12. The collective two-dimensional distribution field of the daily temperature extremities by 1 °C and by stations, December

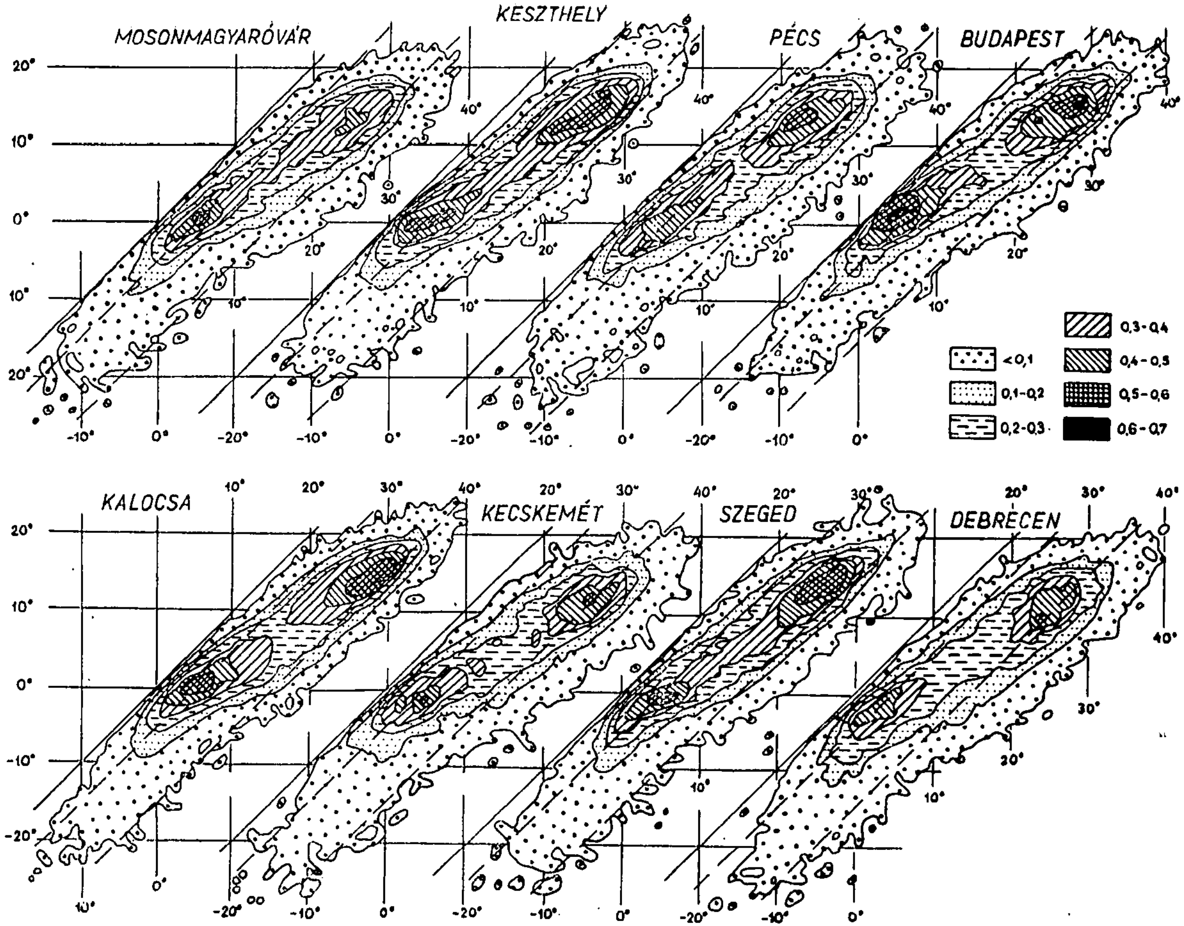

Fig. 13. The collective two-dimensional distribution field of the daily temperature extremities by 1 °C and by stations, year

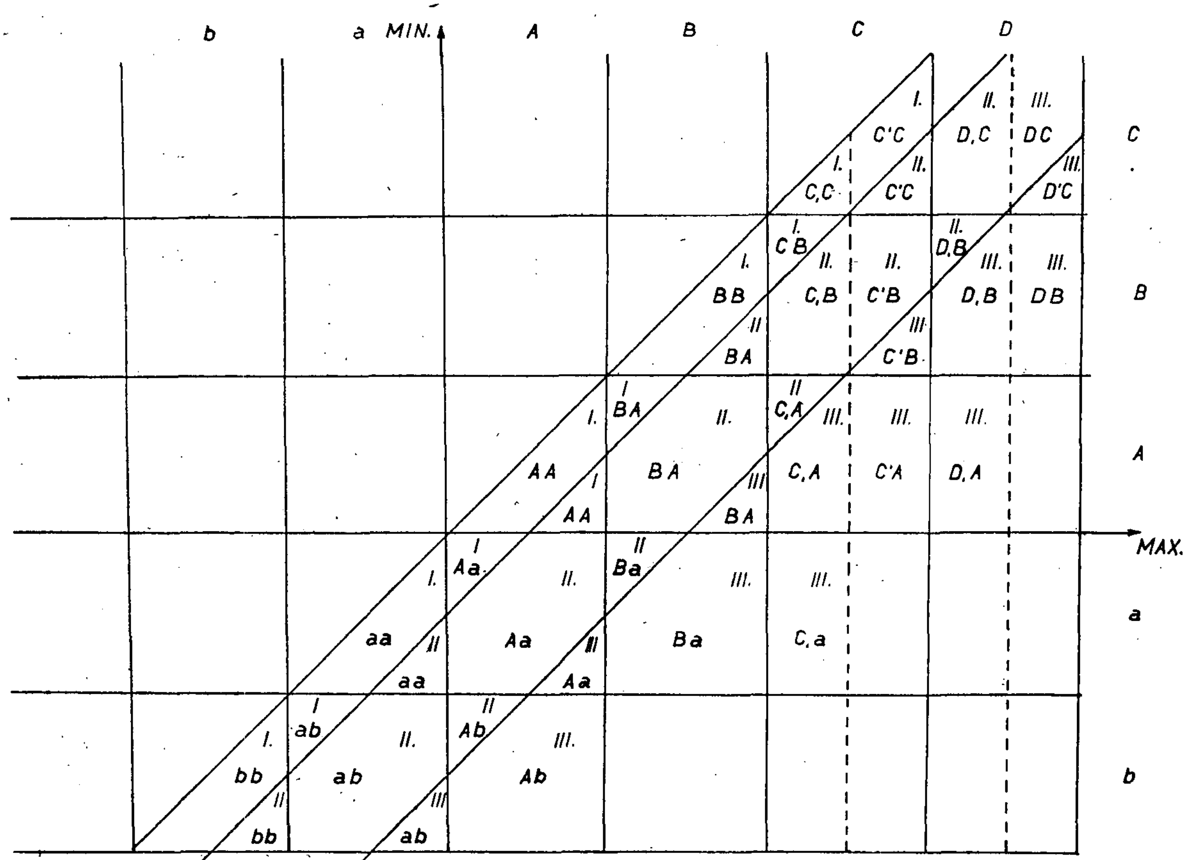

Fig. 14. The codifying system of the daily temperature extremities, types of two-dimensional threshold days

Table 1

The yearly collective frequency of the temperature extremities' threshold days according to two-dimensional codifying types by stations, day

		1	2	3	4	5	6	7	8
c	c	0,55	—	—	—	—	0,09	—	0,04
b	b	0,55	0,51	0,55	0,44	0,62	0,62	0,91	0,55
b	c	0,22	0,04	0,33	0,05	0,22	0,88	0,47	0,91
a	a	15,16	15,55	18,10	16,02	15,07	19,14	18,14	19,57
a	b	8,36	6,27	8,04	5,44	4,71	12,53	9,78	15,19
a	c	0,22	0,11	0,40	0,02	0,22	0,69	0,37	1,24
A	A	50,32	48,06	40,19	58,39	49,28	33,42	35,73	26,66
A	a	54,91	50,33	56,18	44,49	48,58	62,78	60,97	68,00
A	b	0,88	0,80	0,99	0,29	0,84	1,39	0,69	2,92
B	B	19,36	21,83	19,49	19,07	16,94	13,00	15,40	10,08
B	A	*80,67*	*81,86*	*79,95*	*74,24*	*79,75*	*75,85*	*79,09*	*69,90*
B	a	6,57	4,38	8,07	2,81	4,16	11,72	6,02	17,03
C,	C	—	—	—	0,02	0,02	—	0,02	—
C,	B	44,48	51,68	47,55	45,44	44,74	35,72	45,88	30,02
C,	A	21,04	16,17	19,28	14,78	17,37	27,50	17,70	32,47
C,	a	0,04	—	0,08	0,02	—	0,11	—	0,44
C'	C	0,18	0,77	0,58	0,66	0,40	0,04	0,29	0,02
C'	B	46,65	50,83	45,59	56,94	55,73	45,76	52,80	39,42
C'	A	3,62	0,95	4,89	2,34	1,68	7,34	1,83	12,82
D,	C	0,29	1,61	1,13	2,79	1,99	0,29	1,28	0,04
D,	B	10,50	12,74	12,78	19,08	20,73	14,64	16,13	15,52
D,	A	0,06	—	0,07	0,02	0,02	0,37	0,04	0,80
D'	C	0,18	0,47	0,13	1,02	1,19	0,15	0,69	0,15
D'	B	0,44	0,29	0,88	0,88	0,99	1,13	1,02	1,46
Total		365,25	365,25	365,25	365,25	365,25	365,25	365,25	365,25

1 = Mosonmagyaróvár, 2 – Keszthely, 3 = Pécs, 4 = Budapest, 5 = Kalocsa, 6 = Kecskemét, 7 = Szeged, 8 = Debrecen

Table 2

The yearly collective frequency of the daily temperature extremities' threshold days according to two-dimensional codifying types during little temperature oscillations by stations, day

		1	2	3	4	5	6	7	8
b	c	—	—	—	0,02	—	0,07	0,03	—
b	b	0,32	0,32	0,34	0,13	0,26	0,22	0,44	0,18
a	b	1,24	1,12	1,52	0,54	1,07	1,35	1,44	0,65
a	a	11,98	12,19	14,47	9,90	11,28	14,94	13,62	9,95
A	a	22,93	19,74	23,93	14,75	20,12	*20,14*	21,40	*11,88*
A	A	*34,84*	*32,35*	*26,17*	*34,69*	*28,89*	20,12	*22,17*	11,64
B	A	10,53	10,39	10,07	6,43	8,36	5.84	7,38	2,17
B	B	7,92	9,77	8,02	5,51	6,87	4,97	5,77	1,50
C,	B	1,32	2,17	1,43	0,51	1,47	0,51	1,10	0,03
C,	C	—	—	—	0,02	0,02	—	0,02	—
C'	C	—	0,03	—	—	—	—	0,03	—
D,	C	—	—	—	—	—	—	—	—
Total		91,08	88,08	85,95	72,50	78,34	68,16	73,40	38,00

Table 3

The yearly collective frequency of the daily temperature extremities' threshold days according to two-dimensional codifying types during medium temperature oscillations by stations, day

		1	5	3	4	5	6	7	8
c	c	—	—	—	—	—	—	—	—
b	c	0,22	0,05	0,29	0,03	0,22	0,77	0,44	0,97
b	b	0,23	0,20	0,20	0,25	0,37	0,40	0,47	0,35
a	c	0,17	0,05	0,22	0,02	0,17	0,33	0,23	0,82
a	b	7,03	5,12	6,50	4,89	7,38	11,10	8,39	13,98
a	a	4,27	3,37	3,69	6,10	3,76	3,65	4,53	9,58
A	b	0,60	0,68	0,62	0,22	0,77	1,10	0,37	2,00
A	a	31,53	30,64	32,15	29,65	29,85	42,14	39,41	54,70
A	A	15,03	15,72	14,06	23,75	15,24	12,78/	13,55	14,93
B	a	4,40	3,53	5,37	1,97	3,52	7,19	4,75	5,76
B	A	66,80	*70,38*	*67,20*	*64,73*	*69,50*	*66,54*	*69,97*	*59,44*
B	B	11,31	13,16	11,43	13,55	10,00	8,03	9,64	8,56
C,	A	13,80	11,01	12,43	7,78	13,90	18,08	13,95	12,45
C,	B	43,33	49,54	46,09	44,99	43,28	35,17	44,81	29,92
C'	B	39,95	48,40	39,62	46,60	51,76	36,37	49,16	22,14
C'	C	0,18	0,72	0,55	0,69	0,37	0,04	0,26	0,02
D,	B	5,00	9,95	5,66	8,95	14,06	5,73	10,77	1,85
D,	C	0,37	1,60	1,10	2,89	1,97	0,29	1,31	0,05
D'	C	0,12	0,32	0,11	0,37	0,75	0,04	0,37	0,08
Total		244,34	264,44	247,29	257,43	266,87	249,75	272,38	237,60

Table 4

The yearly collective frequency of the daily temperature extremities' threshold days according to two-dimensional codifying types during great temperature oscillations by stations, day

		1	2	3	4	5	6	7	8
b	c	—	—	0,2	—	—	0,02	—	—
a	c	0,05	0,03	0,13	—	0,02	0,37	0,12	0,42
a	b	0,10	0,03	0,13	0,02	0,02	0,09	0,03	0,59
A	c	0,23	0,13	0,32	0,05	0,05	0,29	0,26	0,92
A	a	0,07	0,02	0,16	0,15	0,03	0,33	0,07	1,22
B	a	2,18	0,58	2,78	0,80	0,66	4,49	1,24	11,43
B	A	2,41	1,25	2,56	3,07	1,90	3,65	1,70	8,25
C,	a	0,05	—	0,05	0,02	—	0,11	—	0,44
C,	A	*7,13*	*4,19*	6,83	6,98	3,88	*9,84*	3,79	*20,17*
C'	A	3,60	0,93	4,97	2,37	1,61	7,34	1,79	12,89
C'	B	6,64	2,33	5,92	*10,26*	3,98	9,60	3,62	17,29
D,	A	0,02	0,02	0,07	0,02	0,12	0,37	0,07	0,80
D,	B	6,51	2,78	*7,12*	10,08	*6,02*	9,64	*5,33*	13,72
D'	B	0,79	0,30	0,84	0,95	1,30	1,13	1,15	1,44
D'	C	0,05	0,15	0,07	0,55	0,40	0,07	0,29	0,07
D'	A	—	—	0,03	—	—	0,04	—	—
Total		29,83	12,73	31,98	35,32	19,99	47,34	19,47	89,65

Table 5

The collective frequencies of the daily temperature extremities' threshold days according to two-dimensional codifying types during little, medium and great temperature oscillations, day, January

		1	2	3	4	5	6	7	8
b	c	—	—	—	0,02	—	—	0,08	—
b	b	0,08	0,07	0,02	0,08	0,05	0,05	0,18	0,08
a	b	0,35	0,33	0.39	0,32	0,20	0,27	0,42	0,28
a	a	4,03	*4,42*	*3,93*	4,39	*3,87*	3,54	*4,44*	2,87
A	a	*4,37*	3,75	3,09	4,57	3,75	*3,77*	3,70	*3,36*
A	A	3,83	3,35	3,06	*5,87*	2,97	3,02	1,98	2,12
B	A	0,02	0,02	0,04	0,07	0,03	0,07	0,02	0,03
B	B	—	0,03	—	—	—	—	—	—
Total		12,68	11,97	10,53	15,32	10,87	10,72	10,76	8,71
b	c	0,10	0,02	0,13	—	0,13	0,30	0,23	0,38
b	b	0,27	0,25	0,13	0,18	0,35	0,23	0,39	0,13
a	c	0,04	0,01	0,05	0,02	0,07	0.05	0,08	0,23
a	b	3,68	2,59	2,64	2,68	3,65	4,27	4,05	5,73
a	a	2,64	2,47	2,30	2,53	2,20	2,48	2,75	2,80
A	b	0,13	0,18	0,23	0,02	0,25	0,25	0,17	0,32
A	a	*7,62*	*8,48*	*9,00*	*6,30*	*8,10*	*8,71*	*9,15*	*9,64*
A	a	2,86	2,94	3,54	3,07	3,44	2,32	2,18	1,80
B	a	0,07	0,13	0,27	0,05	0,10	0,07	0,12	0,18
B	A	0,82	1,80	1,84	0,83	1,75	1,29	0,95	0,55
Total		18,24	18,87	20,13	15,68	20,04	19,97	20,07	21,75
a	c	0,02	—	0,02	—	0,02	—	—	0,13
a	b	—	0,02	0,07	—	0,02	0,11	0,03	0,17
A	b	*0,05*	*0,12*	0,05	—	0,02	*0,14*	*0,12*	*0,23*
A	a	0,02	0,02	0,09	—	*0,03*	0,02	—	—
B	a	—	—	0,11	—	—	0,04	0,02	—
Total		0,09	0,16	0,34	—	0,09	0,31	0,17	0,53
		31,0	31,0	31,0	31,0	31,0	31,0	31,0	31,0

Table 6

The collective frequencies of the daily temperature extremities' threshold days according to two-dimensional codifying types during little, medium and gerat temperature oscillations, day, February

		1	2	3	4	5	6	7	8
b	c	0,02	—	—	—	—	—	—	—
b	b	0,10	0,05	0,05	0,02	0,05	0,02	—	—
a	b	0,18	0,17	0,07	0,10	0,07	0,05	0,12	0,10
a	a	2,53	1,72	1,61	1,59	1,66	1,30	1,24	0,86
A	a	*2,94*	2,33	2,24	3,01	*2,53*	*2,43*	*2,54*	*2,26*
A	A	1,45	*2,50*	*2,54*	*4,34*	1,84	1,79	2,00	1,24
B	A	0,02	0,03	0,05	0,15	0,08	0,05	0,02	0,02
B	B	—	—	0,02	—	0,02	—	—	—
Total		7,24	6,80	6,58	9,21	6,25	5,64	5,92	4,48
b	c	0,15	0,03	0,05	0,03	0,07	0,20	0,10	0,12
b	b	0,08	0,10	0,04	0,02	0,07	0,07	0,03	0,02
a	c	0,13	0,02	0,09	—	0,08	0,13	0,08	0,20
a	b	2,93	1,77	1,88	1,54	2,65	2,91	2,71	3,26
a	a	2,13	1,45	1,27	1,52	1,46	1,27	1,21	1,98
A	b	0,13	0,31	0,32	0,18	0,36	0,36	0,13	0,55

A	a	*10,20*	*9,19*	*8,24*	*7,90*	*9,00*	*9,51*	*9,17*	*11,35*
A	A	2,40	3,64	3,36	4,20	3,48	3,13	3,78	2,46
B	a	0,46	0,81	0,88	0,38	0,45	0,50	0,58	0,68
B	A	1,49	3,24	4,19	2,80	3,60	2,84	3,55	1,75
Total		20,10	20,56	20,34	18,57	21,21	21,01	21,34	22,37
b	c	—	—	—	—	—	—	0,02	—
a	c	0,08	0,05	0,09	—	0,03	0,23	0,13	0,17
a	b	0,10	0,10	0,14	0,02	0,02	0,27	0,08	0,18
A	b	0,15	0,10	0,25	0,03	0,07	0,16	0,03	0,40
A	a	0,03	0,08	0,11	0,07	0,07	0,21	0,05	0,17
B	a	*0,26*	*0,21*	*0,36*	*0,08*	*0,25*	*0,43*	*0,31*	*0,21*
B	A	0,02	0,10	0,13	0,02	0,10	0,05	0,12	0,02
C	A	0,02	—	—	—	—	—	—	—
Total		0,66	0,64	1,08	0,22	0,54	1.35	0,74	1,15
		28,0	28,0	28,0	28,0	28,0	28,0	28,0	28,0

Table 7

The collective frequencies of the daily temperature extremities' threshold days according to two-dimensional codifying types during little, medium and great temperature oscillations, day, March

		1	2	3	4	5	6	7	8
A	a	0,40	0,25	0,23	0,19	0,22	0,14	0,14	0,10
a	a	1,58	0,88	0,80	0,81	0,94	0,91	0,91	0,65
A	A	*1,87*	*5,72*	*2,07*	*3,02*	*2,09*	*1,43*	*3,58*	*1,12*
B	A	0,12	0,30	0,20	0,34	0,05	0,13	0,24	0,15
B	B	—	0,08	0,05	—	0,03	—	0,02	0,02
Total		3,97	7,23	3,35	4,36	3,33	2,61	4,89	2,04
a	b	0,22	0,05	0,05	0,03	0,13	0,27	0,10	0,22
a	a	0,42	0,25	0,20	0,15	0,30	0,27	0,29	0,47
A	b	0,20	0,03	0,02	—	0,02	0,09	0,03	0,15
A	a	*9,88*	6,24	6,25	5,77	6,56	8,09	7,03	9,58
A	A	3,97	1,20	3,74	5,11	4,15	3,95	1,91	2,74
B	a	1,50	1,13	0,88	0,89	1,27	1,64	1,23	1,62
B	A	7,80	*12,24*	*11,90*	*11,52*	*11,85*	*9,32*	*11,80*	*8,18*
B	B	0,03	0,18	0,30	0,27	0,08	0,13	0,10	0,13
C,	A	0,13	0,30	0,50	0,35	0,55	0,23	0,59	0,15
C,	B	—	0,10	0,48	0,15	0,15	0,05	0,14	—
Total		24,15	21,72	24,33	24,24	25,06	24,04	23,22	23,24
a	b	0,03	—	—	—	—	—	0,02	0,05
A	b	0,07	0,02	0,07	—	0,02	0,04	0,03	0,18
A	a	—	0,05	0,13	0,02	0,07	0,16	0,07	0,37
B	a	*1,48*	0,48	1,16	0,52	0,50	*1,66*	0,73	*3,10*
B	A	0,98	*0,88*	*1,21*	*1,15*	*1,32*	1,59	*1,23*	1,22
C,	a	0,02	—	0,05	0,02	—	—	—	0,10
C,	A	0,30	0,62	0,66	0,69	0,70	0,88	0,81	0,60
C,	B	—	—	0,04	—	—	0,02	—	—
		2,88	2,05	3,32	2,40	2,61	4,35	2,89	5,72
Total		31,0	31,0	31,0	31,0	31,0	31,0	31,0	31,0

Table 8

The collective frequencies of the daily temperature extremities' threshold days according to two-dimensional codifying types during little, medium and great temperature oscillations, day, April

		1	2	3	4	5	6	7	8
a	a	—	—	—	—	—	0,02	—	—
A	a	0,14	0,07	0,04	0,02	0,02	0,07	0,03	0,10
A	A	*1,37*	*0,80*	*0,95*	0,85	*0,77*	*0,80*	*0,85*	*0,57*
B	A	0,32	0,77	0,75	*1,02*	0,52	0,70	0,45	0,23
B	B	0,03	0,16	0,18	0,27	0,15	0,13	0,10	0,02
Total		1,86	1,80	1,92	2,16	1,46	1,72	1,43	0,92
A	a	1,98	0,77	0,57	0,41	0,82	0,97	0,72	1,50
A	A	2,27	1,73	1,48	1,56	1,54	1,52	1,27	1,28
B	a	1,24	0,33	0,32	0,34	0,48	0,79	0,43	1,23
B	A	*14,91*	*17,00*	*14,80*	*15,69*	*15,87*	*14,66*	*15,62*	*12,77*
B	B	0,36	1,33	1,04	1,42	1,17	0,66	1,05	0,48
C,	A	1,42	1,68	2,15	1,86	2,42	1,77	2,33	1,53
C,	B	0,51	2,22	2,32	2,52	1,87	1,27	2,27	0,77
C'	B	0,10	0,30	0,50	0,46	0,57	0,36	0,67	0,40
D,	B	—	—	—	—	—	—	0,02	—
Total		22,79	25,36	23,18	24,26	24,72	22,00	24,38	19,96
A	a	0,02	—	0,02	—	—	0,02	—	0,08
B	a	1,05	0,12	0,61	0,15	0,22	0,68	0,20	2,22
B	A	1,54	0,67	1,05	0,74	1,03	1,66	0,92	1,85
C,	a	—	—	0,02	—	—	—	—	0,13
C,	A	*2,42*	*1,55*	*2,20*	*1,86*	*1,69*	*2,86*	*2,03*	*3,48*
C'	A	0,25	0,23	0,64	0,32	0,35	0,59	0,40	0,98
C'	B	0,07	0,27	0,36	0,54	0,53	0,45	0,62	0,35
D,	B	—	—	—	—	—	0,02	0,02	0,03
Total		5,35	2,84	4,90	3,58	3,82	6,28	4,19	9,12
		30,0	30,0	30,0	30,0	30,0	30,0	30,0	30,0

Table 9

The collective frequencies of the daily temperature extremities' threshold days according to two-dimensional codifying during little, medium and great temperature oscillations, day, May

		1	2	3	4	5	6	7	8
a	a	—	—	0,02	—	—	—	—	—
A	A	0,34	0,18	0,13	0,07	0,07	0,07	0,07	0,07
B	A	*0,41*	0,58	0,86	0,44	0,45	0,38	0,23	*0,20*
B	B	0,40	*0,88*	*1,45*	*0,74*	*0,58*	*0,59*	*0,48*	0,15
C,	B	—	0,05	0,18	0,07	0,03	—	0,03	—
C'	B	—	0,03	0,02	—	—	—	—	—
Total		1,15	1,72	2,66	1,32	1,13	1,04	0,81	0,42
A	a	0,03	—	—	—	—	0,04	—	0,02
A	A	0,02	0,08	0,07	0,05	0,13	0,05	0,07	0,01
B	a	0,17	—	0,02	—	0,02	0,04	—	0,02
B	A	*10,15*	7,34	5,52	5,68	6,49	6,44	5,58	*5,82*
B	B	2,05	3,14	2,00	2,91	2,63	2,58	2,71	1,52

C,	A	3,18	2,45	1,95	1,66	2,47	2,58	2,19	2,38
C,	B	5,60	*8,85*	*8,80*	*8,42*	*8,25*	*6,60*	*8,38*	5,28
C'	B	2,05	4,75	4,23	5,41	5,79	3,99	6,60	2,88
C'	C	—	—	0,05	—	—	—	0,02	—
D,	B	—	0,15	0,16	0,47	0,33	0,30	0,27	0,08
D,	C	—	—	0,04	0,02	0,02	—	—	—
Total		23,25	26,74	22,84	24,62	26,13	22,62	25,82	18,01
B	a	0,17	—	0,16	—	—	0,07	0,02	0,42
B	A	0,96	0,28	0,23	0,22	0,22	0,47	0,17	0,75
C,	a	0,02	—	0,02	—	—	—	—	0,05
C,	A	*3,14*	*1,10*	*1,90*	*1,74*	1,12	*2,63*	1,12	*4,02*
C'	A	0,74	0,08	1,04	0,61	0,25	1,14	0,57	2,95
C'	B	1,50	0,98	1,72	1,98	*1,72*	2,29	*1,80*	3,10
D,	A	—	—	—	0,02	—	0,02	—	0,12
D,	B	0,07	0,10	0,43	0,49	0,43	0,72	0,69	1,13
Total		6,60	2,54	5,50	5,06	3,74	7,34	4,37	12,57
		31,0	31,0	31,0	31,0	31,0	31,0	31,0	31,0

Table 10

The collective frequencies of the daily temperature extremities' threshold days according to two-dimensional codifying types during little, medium and great temperature oscillations, day, June

		1	2	3	4	5	6	7	8
B	A	0,19	0,05	0,02	0,02	0,05	—	0,03	0,02
B	B	*0,76*	*0,57*	*0,80*	*0,70*	*0,58*	*0,48*	*0,50*	*0,33*
C,	B	0,03	0,12	0,07	0,07	0,03	0,04	0,05	0,03
C,	C	—	—	0,02	—	—	—	0,02	—
Total		0,98	0,74	0,91	0,79	0,66	0,52	0,60	0,38
B	A	3,74	1,12	0,50	0,52	0,77	1,00	0,63	1,03
B	B	2,98	2,80	2,23	1,90	2,08	1,93	1,65	1,37
C,	A	2,10	1,07	0,89	0,72	1,05	1,25	0,75	1,48
C,	B	*8,45*	*10,50*	*9,52*	9,55	8,93	7,50	9,01	*7,02*
C'	B	5,89	9,42	9,26	*10,31*	*10,12*	*9,89*	*10,85*	6,36
C'	C	—	0,18	0,25	0,15	0,03	0,05	0,17	—
D,	B	0,27	1,22	0,89	1,55	2,12	0,93	2,39	0,82
D,	C	0,02	0,20	0,41	0,40	0,20	0,09	0,33	0,07
D'	C	—	—	0,02	—	—	0,02	0,03	0,02
Total		23,45	26,52	23,97	25,10	25,30	22,66	25,81	18,18
B	a	—	—	—	—	—	—	—	0,03
B	A	0,05	—	0,07	0,03	0,03	0,05	0,02	0,08
C,	A	1,40	0,37	0,63	0,38	0,30	1,13	0,17	1,64
C'	A	0,81	0,12	0,55	0,18	0,17	1,13	0,10	1,82
C'	B	*2,52*	*1,48*	*1,90*	*1,82*	*1,90*	*1,57*	1,28	*3,97*
D,	A	0,02	—	0,40	—	—	0,02	—	0,10
D,	B	0,77	0,73	1,50	1,62	1,57	*2,68*	*1,77*	3,67
D'	B	—	0,02	0,07	0,05	0,02	0,02	0,15	0,13
D'	C	—	0,02	—	0,03	0,05	0,04	0,10	—
Total		5,57	2,74	5,12	4,11	4,04	6,82	3,59	11,44
		30,0	30,0	30,0	30,0	30,0	30,0	30,0	30,0

Table 11

The collective frequencies of the daily temperature extrémities' threshold days according to two-dimensional codifying types during little, medium and great temperature oscillations, day, July

		1	2	3	4	5	6	7	8
B	A	0,05	—	—	—	—	—	—	—
B	B	*0,68*	*0,53*	*0,52*	*0,43*	*0,38*	*0,41*	*0,37*	*0,17*
C,	B	0,02	0,25	0,12	0,18	0,18	0,14	0,17	0,05
C,	C	—	—	—	0,02	0,02	0,02	—	—
C'	C	—	—	0,02	—	—	—	0,03	—
Total		0,75	0,78	0,66	0,63	0,58	0,57	0,57	0,22
B	A	0,65	0,08	—	0,03	0,02	0,07	—	0,05
B	B	2,32	1,17	0,80	0,60	0,75	0,38	0,33	0,67
C,	A	0,77	0,23	0,21	0,07	0,15	0,29	0,07	0,45
C,	B	*9,76*	8,52	7,00	5,98	6,47	5,96	6,25	5,84
C'	B	8,92	*12,67*	*11,44*	*12,68*	*12,06*	*10,11*	*12,54*	*8,07*
C'	C	0,03	0,03	0,05	0,27	0,25	0,07	0,23	0,02
D,	B	0,80	3,02	2,63	3,65	4,02	2,20	3,70	1,48
D,	C	0,17	0,83	1,38	1,97	1,07	0,52	1,68	0,27
D'	C	—	0,08	0,11	0,25	0,30	0,02	0,35	0,08
Total		23,42	26,62	23,62	25,50	25,09	19,62	25,15	16,93
C,	A	0,42	0,03	0,14	0,02	0,02	0,20	0,03	0,48
C'	A	0,50	0,05	0,16	—	0,03	0,41	0,02	1,37
C'	B	*3,10*	1,23	1,73	1,38	1,23	3,68	0,82	4,55
D,	A	0,02	—	—	—	—	0,05	—	0,10
D,	B	2,57	*2,00*	*3,90*	*2,72*	*3,33*	*5,20*	*3,23*	*6,02*
D'	B	0,22	0,10	0,52	0,50	0,40	1,04	0,63	1,13
D'	C	—	0,18	0,23	0,25	0,32	0,23	0,55	0,18
E,	B	—	—	0,02	—	—	—	—	0;02
E,	C	—	—	0,02	—	—	—	—	—
Total	i	6,83	3,59	6,72	4,87	5,33	10,81	5,28	13,85
		31,0	31,0	31,0	31,0	31,0	31,0	31,0	31,0

Table 12

The cto ctive frequencies of the daily temperature extremities' threshold days accord ing two-dimensional codifying types during little, medium and great olle temperature oscillations, day, August

		1	2	3	4	5	6	7	8
B	A	0,07	0,03	—	—	—	—	—	—
B	B	0,94	0,27	0,59	0,57	0,40	0,43	0,35	0,37
C,	B	0,03	0,25	0,27	0,13	0,13	0,14	0,05	0,05
Total		1,04	0,55	0,86	0,70	0,53	0,57	0,40	0,42
B	A	1,17	0,33	0,07	0,03	0,13	0,27	0,18	0,40
B	B	2,38	1,36	1,02	0,72	1,08	0,84	0,85	0,83
C,	A	1,66	0,44	0,36	0,17	0,23	0,61	0,02	1,05
C,	B	*10,00*	9,82	7,80	7,56	8,06	7,02	7,40	6,23
C'	B	7,25	*11,05*	*9,72*	*11,68*	*10,50*	*8,31*	*12,00*	*7,45*
C'	C	0,02	0,23	0,27	0,23	0,10	0,02	0,20	0,02
D,	B	0,45	2,50	2,11	2,64	2,55	1,55	3,52	0,90
D,	C	—	0,53	0,66	0,85	0,65	0,27	0,85	0,05
D'	C	—	0,05	0,05	0,12	0,12	0,04	0,18	—
Total		22,93	26,31	22,06	24,00	23,42	18,53	25,20	16,93

C,	A	0,65	0,25	0,20	—	0,12	0,50	0,02	1,02
C'	A	0,70	0,08	0,34	0,17	0,07	0,89	0,02	1,83
C'	B	3,30	1,43	2,21	1,95	1,75	4,00	1,08	4,00
D,	A	0,02	0,02	0,02	—	—	0,07	—	0,30
D,	B	2,18	*2,05*	*4,16*	*3,52*	*4,20*	*5,16*	*2,87*	*5,37*
D'	B	0,13	0,18	0,95	0,38	0,53	0,77	0,78	0,98
D'	C	0,05	0,13	0,20	0,28	0,38	0,11	0,63	0,15
Total		7,03	4,14	8,08	6,30	7,05	11,50	5,40	13,65
		31,0	31,0	31,0	31,0	31,0	31,0	31,0	31,0

Table 13

The collective frequencies of the daily temperature extremities' threshold days according to two-dimensional codifying types during little, medium and great temperature oscillations, day, September

		1	2	3	4	5	6	7	8
A	A	0,12	0,07	0,11	0,05	0,08	0,09	0,03	0,05
B	A	0,73	0,50	0,47	0,23	0,28	0,21	0,27	0,07
B	B	*1,02*	*0,98*	*1,24*	*1,15*	*1,03*	*0,59*	*0,78*	*0,40*
C,	B	0,03	0,05	0,13	0,07	0,05	0,02	0,07	—
C,	C	—	—	—	—	—	0,02	—	—
Total		1,90	1,60	1,95	1,50	1,44	0,93	1,15	0,52
A	a	—	—	—	—	0,02	0,02	—	0,02
A	A	0,08	0,02	0,05	0,02	0,05	0,04	0,07	0,02
B	a	0,03	—	—	—	—	—	—	0,05
B	A	8,65	5,24	3,34	4,00	4,18	5,12	4,35	6,20
B	B	2,90	3,30	2,98	3,30	2,78	2,23	2,70	1,72
C,	A	2,02	1,67	1,38	1,65	1,62	2,12	1,82	2,98
C,	B	5,74	*8,60*	*7,78*	*7,75*	*7,44*	*5,90*	*8,02*	*4,80*
C'	B	2,28	5,63	4,92	5,42	5,80	3,53	6,23	3,80
C'	C	—	—	0,04	0,02	0,03	—	0,02	0,02
D,	B	0,02	0,40	0,63	0,58	0,52	0,37	0,55	0,32
D,	C	—	0,03	0,07	0,03	0,03	0,02	0,10	0,02
Total		21,73	24,89	21,19	22,77	22,47	19,35	23,86	19,95
B	a	0,10	—	—	—	—	0,07	—	0,02
B	A	0,48	0,12	0,23	0,17	0,17	0,57	0,05	0,60
C,	A	*2,78*	1,22	1,47	1,23	1,45	2,75	0,63	3,13
C'	A	0,98	0,32	1,24	0,80	0,58	1,53	0,58	2,60
C'	B	*1,47*	*1,32*	*2,50*	*2,23*	*2,22*	*3,02*	*2,07*	1,60
D,	a	—	—	—	—	—	—	—	0,02
D,	A	0,08	—	0,02	—	0,02	0,20	0,02	0,18
D,	B	0,48	0,53	1,36	1,28	1,62	1,52	1,58	1,28
D'	B	—	—	0,04	0,02	0,03	0,02	0,03	—
D'	A	—	—	—	—	—	0,04	—	—
D'	C	—	—	—	—	—	—	0,03	—
		6,37	3,51	6,86	5,73	6,09	9,72	4,99	9,53
Total		30,0	30,0	30,0	30,0	30,0	30,0	30,0	30,0

Table 14

The collective frequencies of the daily temperature extremities' threshold days according to two-dimensional codifying types during little, medium and great temperature oscillations, day, October

		1	2	3	4	5	6	7	8
a	a	0,02	—	0,02	—	—	—	—	—
A	a	0,18	0,03	0,05	0,03	0,05	0,02	0,05	0,03
A	A	*2,34*	*1,55*	1,79	1,60	*1,60*	*1,34*	*1,48*	*0,85*
B	A	1,20	1,50	1,45	*1,80*	1,00	0,89	1,07	0,60
B	B	0,43	0,88	*3,06*	1,25	0,70	0,47	0,82	0,42
C,	C	—	—	—	—	—	—	0,02	—
Total		4,17	3,96	6,37	4,68	3,35	2,72	3,44	1,90
a	b	—	—	—	—	—	0,02	0,18	0,03
a	a	0,03	—	—	—	0,02	0,02	0,02	0,02
A	b	—	—	—	—	0,02	0,02	—	—
A	a	1,37	0,35	0,25	0,37	0,35	0,64	0,28	1,13
A	A	2,32	1,09	0,80	0,98	1,32	1,00	1,08	1,17
B	a	0,85	0,23	0,18	0,18	0,23	0,43	0,15	0,98
B	A	*16,06*	*16,05*	*11,90*	*15,26*	*14,88*	*14,46*	*15,30*	*13,60*
B	B	1,15	2,50	2,00	2,20	1,85	1,45	2,04	1,28
C,	A	0,87	1,42	1,41	1,30	1,82	1,63	1,57	1,03
C,	B	1,22	3,29	1,77	2,97	3,05	2,13	3,50	1,86
C'	B	0,05	0,35	0,82	0,62	0,90	0,63	0,78	—
Total		23,92	25,27	19,13	23,88	24,44	22,43	24,90	21,10
A	a	—	—	—	—	—	—	—	0,05
B	a	0,90	0,07	0,27	0,03	0,12	0,89	0,03	*2,60*
B	A	*0,97*	*0,78*	1,14	0,75	0,97	1,74	0,70	2,06
C,	a	—	—	0,02	—	—	—	—	0,10
C,	A	0,90	*0,78*	*3,30*	*1,02*	*1,47*	*2,18*	*1,35*	2,52
C'	A	0,12	0,05	0,45	0,27	0,22	0,43	0,13	0,32
C'	B	0,02	0,08	0,32	0,37	0,43	0,57	0,40	0,30
D,	C	—	—	—	—	—	—	0,05	0,05
Total		2,91	1,76	5,50	2,44	3,21	5,81	2,66	8,00
		31,0	31,0	31,0	31,0	31,0	31,0	31,0	31,0

Table 15

The collective frequencies of the daily temperature extremities' threshold days according to two-dimensional codifying types during little, medium and great temperature oscillations, day, November

		1	2	3	4	5	6	7	8
a	a	1,20	0,62	0,38	0,50	0,50	0,56	0,48	0,50
A	a	2,77	1,52	1,29	1,62	1,50	1,72	1,45	1,30
A	A	*5,88*	*7,09*	*7,36*	*8,65*	*5,28*	*3,78*	*4,23*	*4,15*
B	A	0,75	1,40	1,54	2,03	1,18	1,27	1,37	0,98
B	B	0,07	0,12	0,25	0,37	0,18	0,11	0,30	0,13
Total		10,67	10,75	10,82	13,17	8,64	7,44	7,83	7,06
a	b	0,17	0,07	—	0,05	0,13	0,22	0,03	0,43
a	a	0,42	0,12	0,23	0,28	0,40	0,51	0,38	0,55
A	b	0,05	—	—	—	0,05	0,18	0,02	0,30
A	a	*7,60*	5,11	4,85	4,18	5,17	6,60	5,18	7,50
A	A	4,92	4,32	2,28	4,55	4,95	4,59	5,07	3,95
B	a	0,32	0,32	0,50	0,15	0,33	0,69	0,43	0,62

B	A	5,50	*8,67*	*9,90*	*7,18*	*9,50*	*8,87*	*10,27*	*8,05*
B	B	0,12	0,32	0,54	0,23	0,35	0,11	0,35	0,37
C,	A	0,02	0,10	0,20	0,05	0,13	0,14	0,08	0,05
C,	B	0,05	0,15	0,29	0,12	0,17	0,11	0,07	0,07
Total		19,17	19,18	18,79	16,79	21,18	22,02	21,88	21,88
a	b	0,02	—	—	—	—	—	—	—
A	b	—	—	—	—	—	0,02	—	0,15
A	a	0,03	—	0,02	0,02	0,02	0,09	—	0,08
B	a	*0,08*	*0,07*	*0,20*	*0,02*	0,07	*0,22*	0,05	*0,43*
B	A	0,03	—	0,13	—	*0,07*	0,14	*0,12*	0,32
C,	A	—	—	0,04	—	0,02	0,07	*0,12*	0,08
Total		0,16	0,07	0,39	0,04	0,18	0,54	0,29	1,06
		30,0	30,0	30,0	30,0	30,0	30,0	30,0	30,0

Table 16

The collective frequencies of the daily temperature extremities' threshold days according to two-dimensional codifying types during little, medium and great temperature oscillations, day, December

		1	2	3	4	5	6	7	8
b	b	0,08	0,02	0,05	0,03	0,05	0,05	0,08	0,03
a	b	0,18	0,17	0,16	0,12	0,13	0,02	0,03	0,12
a	a	4,35	2,98	2,90	2,92	2,82	3,07	2,45	2,67
A	a	*5,84*	4,57	3,28	4,34	2,59	3,70	3,84	3,95
A	A	5,17	*8,32*	*6,04*	*10,14*	*5,51*	*7,30*	*5,61*	*4,74*
B	A	0,15	0,27	0,40	0,32	0,32	0,25	0,40	0,27
B	B	—	0,03	0,05	0,03	—	0,02	—	—
Total		15,77	16,36	12,88	17,90	11,42	14,41	12,41	11,78
b	c	0,07	—	—	—	0,02	0,09	0,02	0,13
b	b	0,05	0,03	0,04	0,07	0,07	0,07	0,05	0,02
a	c	0,03	—	0,04	—	0,02	0,02	—	0,10
a	b	1,80	1,00	0,97	0,83	1,43	2,04	1,47	2,28
a	a	1,97	1,25	1,18	1,60	1,62	1,45	1,31	1,82
A	b	0,03	0,03	0,09	0,03	0,08	0,09	0,08	0,35
A	a	*7,45*	*7,10*	*7,50*	*4,92*	*8,45*	*8,20*	*7,51*	*8,65*
A	A	2,52	2,82	4,35	4,15	4,85	2,07	4,98	3,30
B	a	0,13	0,15	0,23	—	0,12	0,11	0,08	0,15
B	A	1,05	2,20	3,50	1,45	2,85	2,27	3,02	2,20
B	B	—	—	—	—	0,03	—	—	—
Total		12,71	14,58	17,90	13,05	19,54	16,41	18,52	19,00
b	c	—	—	—	—	—	—	—	0,02
a	c	0,02	—	—	—	—	*0,04*	—	0,02
a	b	—	—	—	—	—	*0,04*	—	*0,12*
A	b	0,02	*0,02*	*0,06*	—	*0,02*	*0,04*	0,02	0,03
a	a	0,02	*0,02*	0,04	*0,03*	*0,02*	0,02	—	—
B	a	*0,07*	*0,02*	0,12	0,02	—	0,04	*0,05*	—
B	A	—	—	—	—	—	—	—	0,03
Total		0,13	0,06	0,22	0,05	0,04	0,18	0,07	0,22
		31,0	31,0	31,0	31,0	31,0	31,0	31,0	31,0

Table 17

The monthly frequency of days, having little temperature oscillation, by stations

	1	2	3	4	5	6	7	8
I	12,68	11,97	10,53	15,32	10,87	10,72	10,76	8,71
II	7,24	6,80	6,58	9,21	6,25	5,64	5,92	4,48
III	3,97	7,25	3,35	4,36	3,33	2,61	4,89	2,04
IV	1,86	1,80	1,92	2,16	1,46	1,72	1,43	0,92
V	1,15	1,72	2,66	1,32	1,13	1,04	0,81	0,42
VI	0,98	0,74	0,91	0,79	0,66	0,52	0,60	0,38
VII	0,75	0,78	0,66	0,63	0,58	0,57	0,57	0,22
VIII	1,04	0,55	0,86	0,70	0,53	0,57	0,40	0,42
IX	1,90	1,60	1,95	1,50	1,44	0,93	1,15	0,52
X	4,17	3,96	6,37	4,68	3,35	2,72	3,44	1,90
XI	10,67	10,75	10,82	13,17	8,64	7,44	7,83	7,06
XII	16,27	*16,36*	*12,88*	*17,90*	*11,42*	*14,41*	*12,41*	*11,78*
Year	62,68	64,26	59,49	71,74	49,66	48,89	50,21	38,85

Table 18

The monthly frequency of days, having medium temperature oscillation, by stations

	1	2	3	4	5	6	7	8
I	18,74	18,87	20,13	15,68	20,04	19,97	20,07	21,76
II	20,10	20,56	20,34	18,57	21,21	21,01	21,34	22,37
III	24,53	21,72	24,34	24,24	25,06	24,04	23,22	23,24
IV	22,79	25,36	23,18	24,26	24,72	22,40	24,38	19,96
V	23,75	26,74	22,84	24,62	26,13	22,62	25,82	18,01
VI	23,45	26,52	23,97	25,10	25,30	22,70	25,81	18,18
VII	23,62	26,63	23,62	25,50	25,09	19,62	25,15	16,93
VIII	22,93	26,31	22,06	24,00	23,42	18,53	25,20	16,93
IX	21,93	24,89	21,19	22,77	22,47	19,35	23,86	19,95
X	23,92	25,27	19,13	23,88	24,44	22,43	24,90	21,10
XI	19,27	19,18	18,79	16,79	21,18	22,02	21,88	21,88
XII	12,71	14,58	17,90	13,05	19,45	16,41	18,52	19,00
Year	257,74	276,63	257,49	258,46	278,60	251,10	280,15	239,31

Table 19

The monthly frequency of days, having great temperature oscillation, by stations

	1	2	3	4	5	6	7	8
I	0,09	0,16	0,34	—	0,09	0,31	0,17	0,53
II	0,66	0,64	1,08	0,22	0,54	1,35	0,74	1,15
III	2,88	2,05	3,32	2,40	2,61	4,35	2,89	5,72
IV	5,35	2,84	4,90	3,58	3,82	6,28	4,19	9,12
V	6,60	2,54	5,50	5,06	3,74	7,34	4,37	12,57
VI	5,57	2,74	5,12	4,11	4,04	6,82	3,59	11,44
VII	*6,83*	3,59	6,72	4,87	5,33	10,81	5,28	*13,85*
VIII	7,03	*4,14*	*8,08*	*6,30*	*7,05*	*11,50*	*5,40*	13,65
IX	6,37	3,51	6,86	5,73	6,09	9,72	4,99	9,53
X	2,91	1,76	5,50	2,44	3,21	5,81	2,66	8,00
XI	0,16	0,07	0,39	0,04	0,18	0,54	0,29	1,06
XII	0,13	0,06	0,22	0,05	0,04	0,18	0,07	0,22
Year	44,58	24,10	48,03	34,80	36,74	65,01	34,64	86,84

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THE TERRITORIAL STRUCTURE OF CERTAIN STATISTICAL CHARACTERISTICS OF THE EUROPEAN TEMPERATURE FIELD

by

L. Pelle

Az európai hőmérsékleti mező egyes statisztikai jellemzőinek területi rendszere. A tanulmány az európai hőmérsékleti mező szórásának és ferdeségének területi rendszerét és az évi menetét vizsgálja. A szórás délnyugatról északkelet felé növekszik, évi ingása hasonló módon változik. A ferdeség értékei egész évben kicsinyek, nyáron enyhe pozitív, télen enyhe negatív aszimmetria mutatkozik.

The study examines the territorial structure of the standard deviation and skewness of the European temperature field. The standard deviations grow from south-west to north-east and their yearly oscillation alters in the same way, too. The values of the skewness are small in the whole year. There is a slight positive asymmetry during the summer months, while a slight negative one during the winter months.

The most important parameter in characterising the climate of a certain territory is the temperature, it has been continuously measured according to its importnce since the time that its observation begun, and there is a relative long time array at disposal. The temperature mean values of Europe are universally known, its plotting on a map was realized by Hungarian experts on a WMO comission [1]. As a matter of fact, the temperature distribution which was separately established on every area would cover adequately the subject, this, however, cannot be realized in practice. In this way we must accept as satisfactory the examination of parameters characterising the distribution of time arrays measured at a few stations.

In this case the European temperature field is approached with the series of monthly mean temperatures of 80 years (1881—1960) measured at 39 different stations. The standard deviation of these series was calculated as well:

$$\sigma = \sqrt{\frac{n}{n-1} \frac{\sum_{i=1}^{n}(x_i - M)^2}{n}} \tag{1}$$

where

n is the instance number, in this case 80, x: the series number of the previous, M is the mean value. The standard deviation of the monthly series of the 39 stations is displayed on *Table 1*. The yearly line of the standard deviation is generally wellknown, it is great during winter and it is small in summer. It is important, however, to notice the characteristical change of standard deviation with the change of latitude and longitude *(Fig. 1 and 2)*, its value increases with the increment of both. If latitude is indexed with "φ", longitude with "λ", the standard deviation in February with "σ_{II}", in June with "σ_{VI}", the correlational coefficients with "r" the following is obtained: To support previously stated facts $r_{\varphi,\sigma_{II}} = 0{,}59$; $r_{\lambda,\sigma_{VI}} = 0{,}72$; $r_{\varphi,\sigma_{VI}} = 0{,}45$; $r_{\lambda,\sigma_{VI}} = 0{,}62$, with the knowledge of these parameters and the mean values of numerical

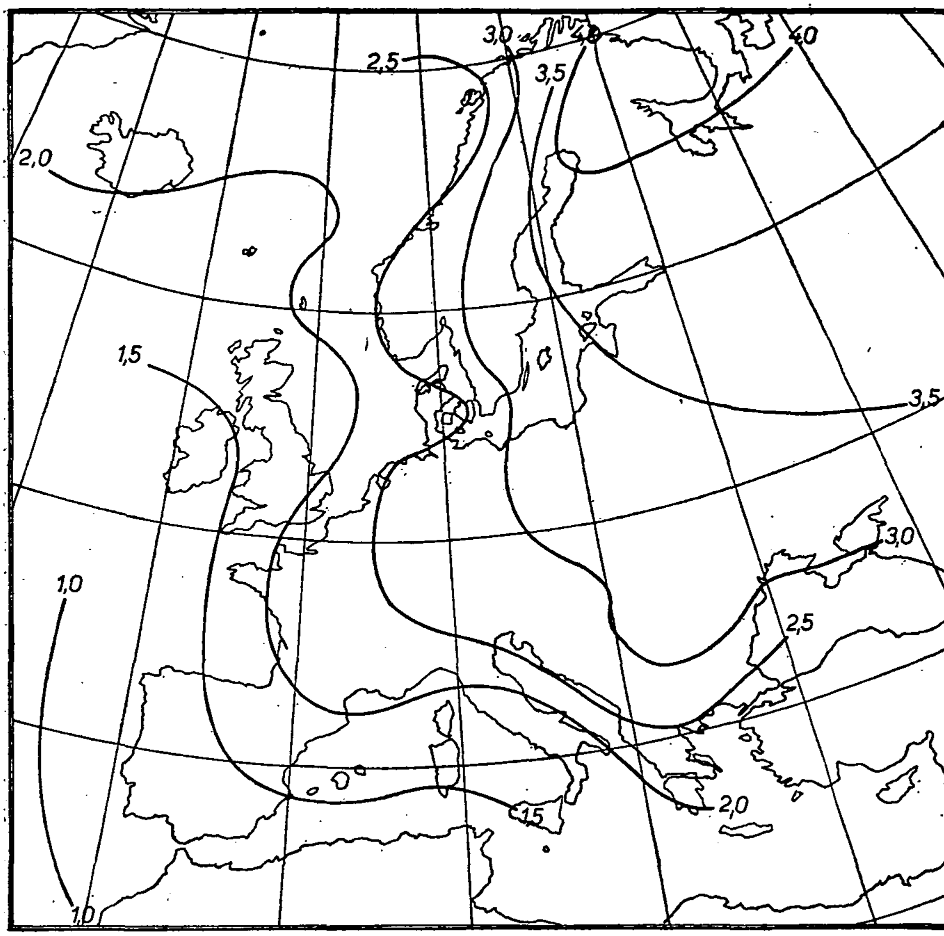

Fig. 1. Standard deviation of monthly mean temperature in February, °C

series of the respective set of datas it was possible to solve the linear, regression equitation with two variables describing the territorial structure of standard deviations:

$$\sigma_{\mathrm{II}} = 0{,}046\varphi + 0{,}013\lambda - 1{,}96$$

$$\sigma_{\mathrm{VI}} = 0{,}018\varphi + 0{,}015\lambda - 0{,}67$$

here with emphasising formerly established statement. These equitations are of course valid only within the examined area. In this way maximal values occur on the Scandinavian Peninsula and on the Northern part of the Eastern European Plain, while minimal values occur in the West, on the coastline of the Atlantic Ocean and in the Mediterraneum during summer and winter as well.

The extreme values of the standard deviation do not ensue on the Continent at the same time, Maximums occur in Middle and Eastern Europe in January, while in Northern, Western and Southern Europe in February. The occurance of minimums

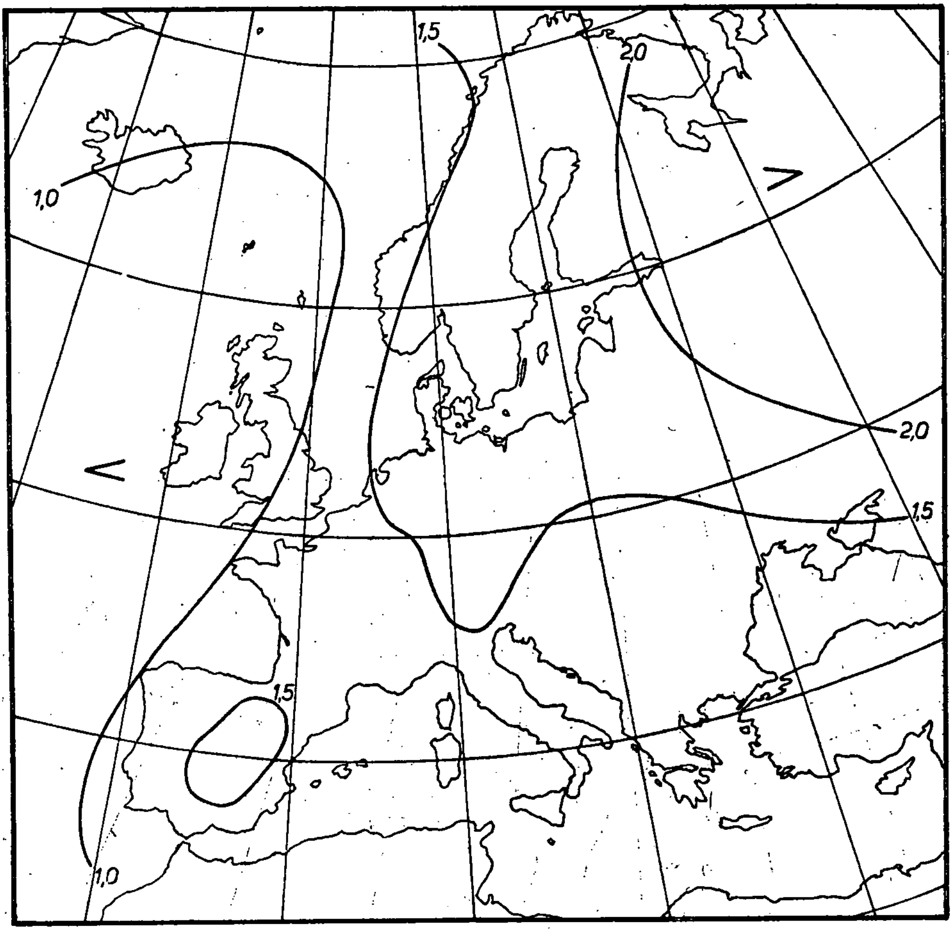

Fig. 2. Standard deviation of monthly mean temperature in June, °C

is less uniformal. On the Atlantic coastline it is in June, along the Mediterranean Sea it is in April, on the continental parts it is in July and in August, in the Eastern part of the Scandinavian Peninsula, in the territory of the White Sea it is in September. The yearly line of standard deviation is characterised by a non-recurring wave-form, but within this there are significant differences *(Fig. 3 and 4)*. The maximal values of oscillation (above 2,5°) occur on the North-Eastern part of the Continent. In Eastern and Middle Europe there are great standard deviation values and the oscillation is great as well (2,2,5°). In Western Europe, with the exception of the British Isles, the yearly oscillation of standard deviation decreases (1—1,5°), the maximal value is less, than 3 °C. In the territory of the Atlantic Ocean and the Mediterranean Sea the characteristical yearly line is hardly recognisable or it cannot be recognized at all, the oscillation is less than 1 °C, it does not even reach 0,5 °C on the South-Western part of Europe, the values of standard deviation are around 1 °C.

Summarizing what was previously written it can be stated that the yearly oscillation of the standard deviation of temperature alters according to the standard deviation on the territory of Europe.

Temperature series are generally described with normal distributional probability variables, since temperature is considered to have a normal distribution.

This supposition was several times proved in practice, but since it is about empiric distributions, normality is not fulfilled in theory, only with a certain approaching. In this way the real distributions deviate to some extent from the normal distribution. Since normaldistribution is symmetrical, the asymmetry, the skewness can be regarded as a degree of deviation. To measure skewness the following parameter was calculated:

$$\gamma = \frac{n}{n-2} \frac{\frac{\sum_{i=1}^{n} (x_i - M)^3}{n}}{\sigma^3} \tag{3}$$

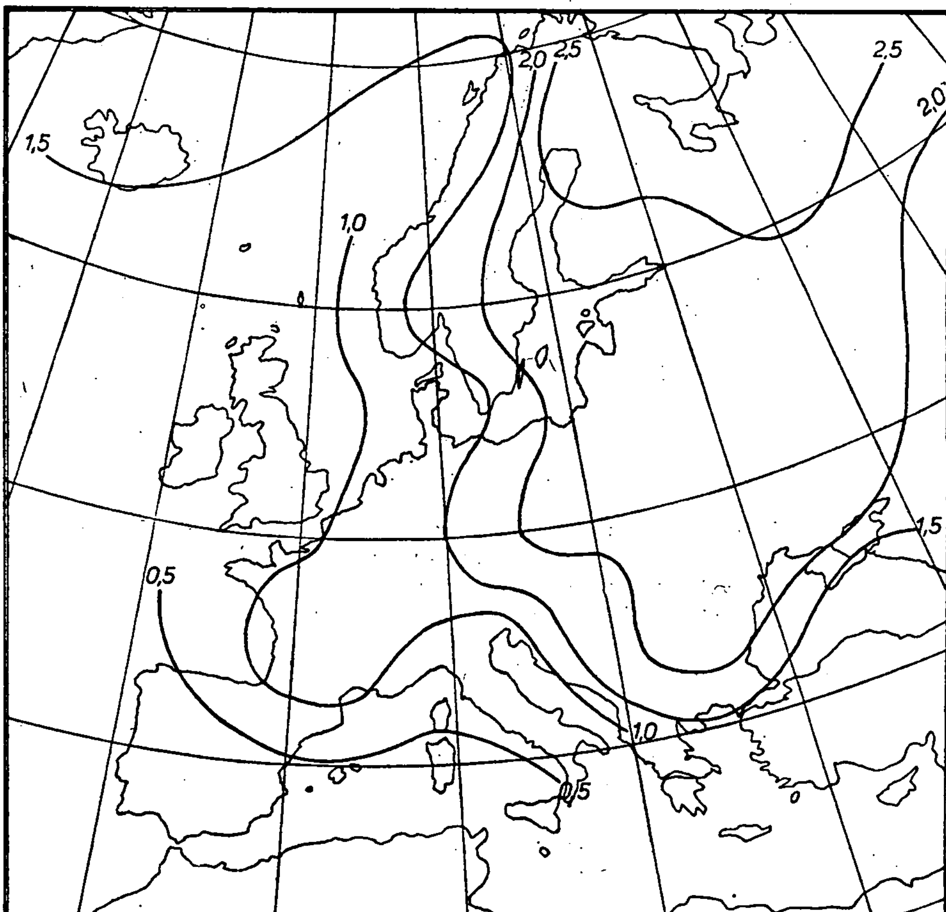

Fig. 3. The difference between the standard deviation of February and June, °C

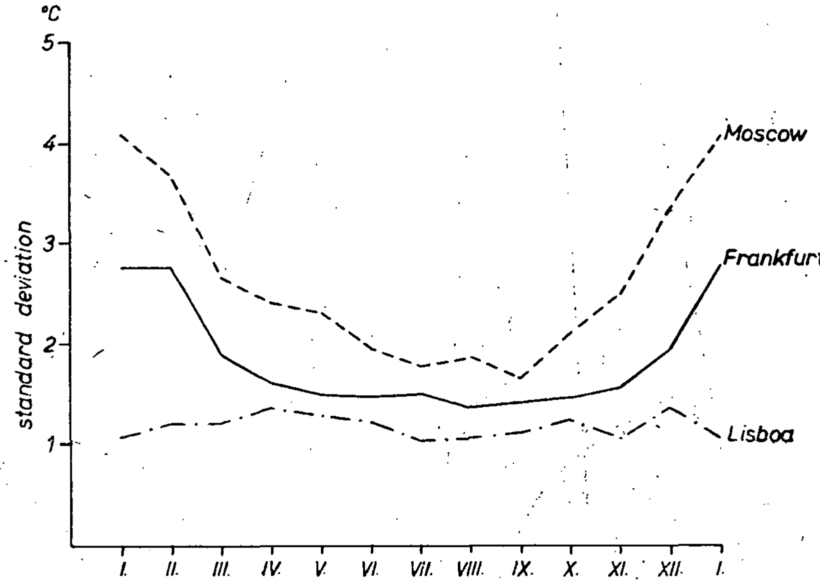

Fig. 4. The yearly line of standard deviation in Moscow, Frankfurt and Lisboa

which is the third central momentum outlined in standard deviation cubic units. The values of skewness can be read in *Table 2.* Generally it can be stated that the values of skewness are small so normaldistribution with a close approaching can be accepted in the examined territory. The territorial structure is less uniformal than in the case of standard deviation, the yearly line is less characteristic, too, but it is still discernable. During the interim seasons the sign of skewness changes without set rules and its absolute value is small as well, in this way this phenomenom can be mostly explained with the deviation between empiric and theoretic momentums. This time principally the normal distribution is fulfilled in this way. During the summer months there is a slight positive asymmetry, while there is a somewhat greater but still unsignificant negative asymmetry during the winter months *(Fig. 5 and 6).* Maximal values occur in both cases in the middle of the territory, in Middle and Western Europe. Both Atlantic and Continental territories are characterised with small values. Since the degree of third central momentum depends on the single directional extreme anomalities, it can be stated, that the territories with greater skewness during summer and winter are those, where Oceanic effects are prevalent, but continental effects can be expected as well. In this way the territories with relatively greater asymmetry — these are more or less the same during winter and summer — can be regarded as an interim territory between the Oceanic and Continantal type temperature distributions.

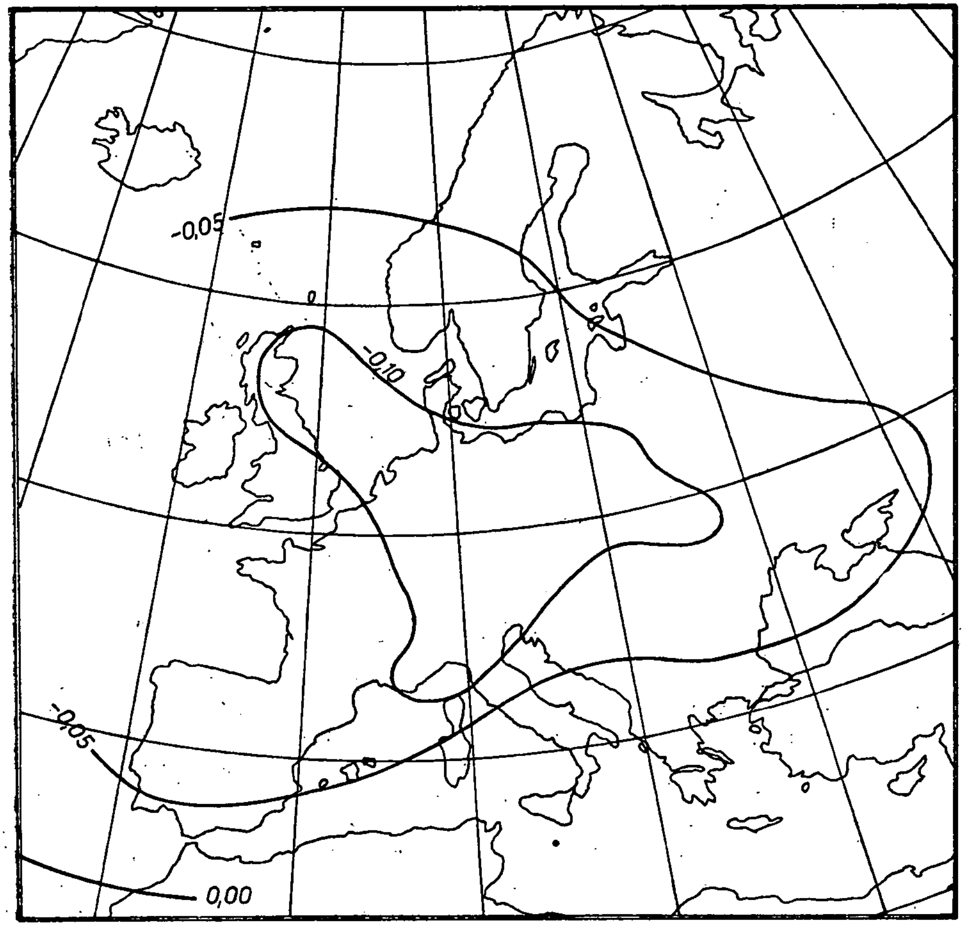

Fig. 5. Skewness of monthly mean temperature in February

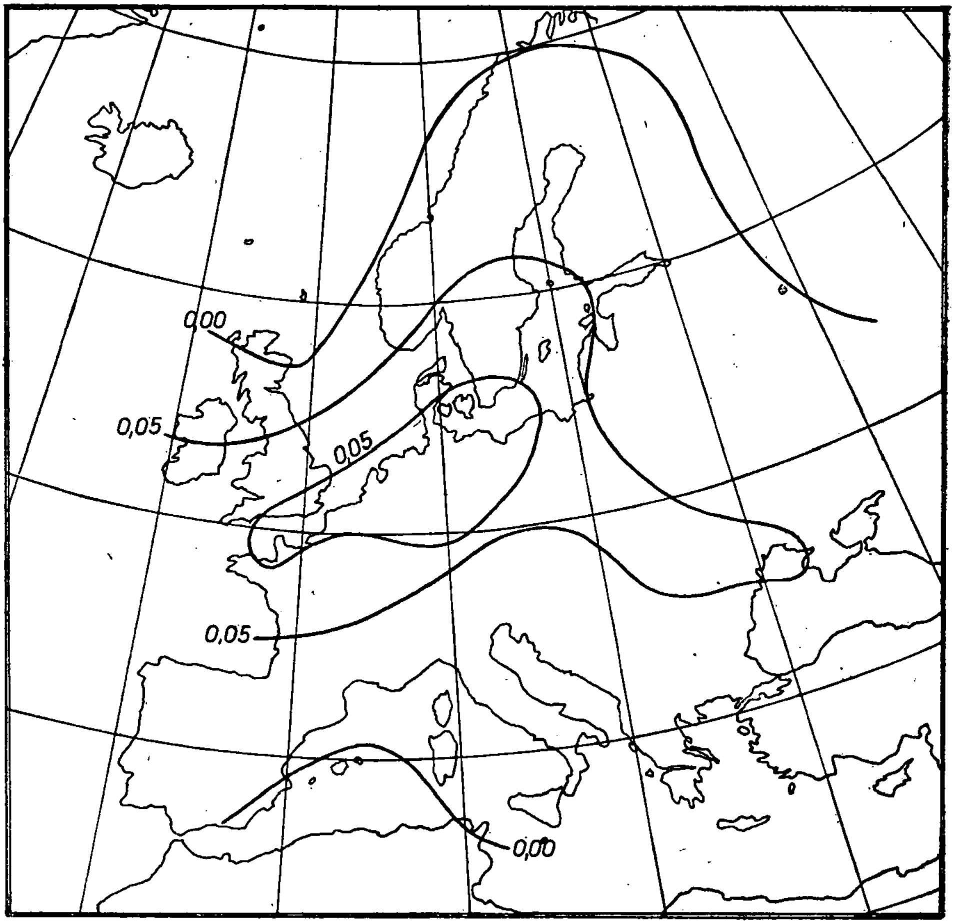

Fig. 6. Skewness of monthly mean temperature in August

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[2] World Weather Records Smithsonian Institution, Washington

Table 1
Standard deviation of monthly averages of temperature °C

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Stykkisholm	2,27	2,34	2,55	1,82	1,66	1,04	0,95	1,11	1,30	1,63	1,43	1,64
Bodó	2,11	2,42	2,05	1,56	1,49	1,52	1,84	1,50	1,34	1,85	1,79	2,25
Haparanda	3,72	4,11	2,91	1,61	1,69	1,75	1,82	1,48	1,37	2,12	2,94	3,85
Arkhangelsk	3,86	3,89	2,91	2,31	2,45	2,26	2,24	2,04	1,50	2,07	2,82	4,33
Wroclaw	3,14	3,42	2,31	1,81	1,55	1,49	1,12	1,24	1,41	1,67	1,85	2,23
Aberdeen	1,39	1,77	1,53	1,09	0,94	0,89	0,91	0,97	0,96	1,13	1,25	1,30
Oslo	2,99	2,96	2,19	1,31	1,57	1,59	1,53	1,46	1,07	1,52	1,78	2,35
Uppsala	2,70	3,43	2,88	1,77	1,65	1,58	1,57	1,49	1,29	1,72	2,00	2,50
Helsinki	3,31	3,68	2,59	1,57	1,76	1,60	1,64	1,56	1,45	1,90	2,17	3,08
Leningrad	3,67	3,80	2,83	2,13	2,40	2,40	2,60	2,42	1,90	1,98	2,18	3,25
Valencia	1,18	1,43	1,25	0,91	0,79	0,80	0,87	0,94	0,84	1,14	1,24	1,12
Basel	2,64	2,85	1,80	1,54	1,46	1,36	1,59	1,40	1,59	1,52	1,50	2,06
Moscow	4,07	3,69	2,66	2,39	2,31	1,95	1,76	1,84	1,66	2,08	2,49	3,34
Kasan	3,72	3,77	2,58	2,52	2,80	2,65	2,88	2,61	2,35	2,32	2,93	3,54
Sibin	3,59	3,20	2,30	1,76	1,59	1,28	1,25	1,47	1,60	1,80	2,60	2,62
Greenwich	1,80	1,96	1,55	1,26	1,13	1,05	1,40	1,30	1,29	1,41	1,39	1,64
De Bilt	2,37	2,68	1,71	1,54	1,50	1,59	1,54	1,47	1,40	1,33	1,55	2,04
Berlin	2,32	1,93	1,84	1,68	2,27	2,64	2,33	2,16	1,87	1,40	1,61	1,94
Kiew	3,49	3,29	2,57	2,20	1,84	1,91	1,60	1,65	1,77	2,16	2,32	2,76
Nantes	2,03	2,26	1,51	1,22	1,18	1,15	1,44	1,43	1,39	1,40	1,57	2,01
Paris	2,34	2,34	1,74	1,51	1,31	1,29	1,57	1,43	1,49	1,55	1,56	2,05
Frankfurt	2,77	2,77	1,88	1,62	1,48	1,46	1,49	1,34	1,42	1,44	1,63	1,95
Zürich	2,41	2,70	1,94	1,70	1,60	1,45	1,60	1,36	1,63	1,52	1,45	1,89
Wien	2,92	2,88	2,11	1,65	1,52	1,31	1,22	1,14	1,46	1,43	1,81	2,16
Budapest	2,89	2,71	2,13	1,68	1,59	1,34	1,23	1,34	1,62	1,58	1,98	2,19
Odessa	3,34	3,06	1,97	1,44	1,58	1,41	1,34	1,39	1,69	2,06	2,50	2,82
Marseille	1,96	2,13	1,27	1,12	1,19	1,10	1,42	1,25	1,37	1,63	1,39	1,70
Geneve	2,10	2,36	1,61	1,41	1,44	1,26	1,60	1,31	1,54	1,32	1,32	1,74
Milano	1,70	2,05	1,61	1,39	1,57	1,45	1,43	1,31	1,43	1,34	1,49	1,31
Szeged	3,24	3,20	2,25	1,75	1,66	1,39	1,33	1,51	1,67	1,74	2,07	2,51
Bukarest	3,34	3,07	2,45	1,72	1,56	1,11	1,20	1,39	1,60	1,87	2,39	2,56
Sulina	3,06	2,64	1,93	1,32	1,27	1,15	1,09	1,03	1,50	1,91	2,41	2,46
Tbilisi	2,09	1,91	1,74	1,51	1,31	1,26	1,07	1,14	1,58	1,57	1,58	1,66
Funchal	0,82	0,80	0,85	0,77	0,59	0,55	0,62	0,70	0,55	0,70	0,85	0,77
Lisboa	1,05	1,22	1,21	1,36	1,27	1,20	1,03	1,04	1,09	1,24	1,05	1,35
Madrid	1,25	1,54	1,60	1,53	1,60	1,61	1,15	1,41	1,34	1,48	1,20	1,35
Palma	1,27	1,59	1,18	1,15	1,16	1,20	1,26	1,25	1,21	1,32	1,25	1,22
Róma	1,52	1,60	1,17	1,00	1,18	1,28	1,25	1,02	1,25	1,30	1,32	1,31
Taskent	3,46	3,32	2,46	1,66	1,43	1,29	0,97	0,96	1,07	1,70	2,38	3,23
København	2,15	2,48	2,04	1,40	1,21	1,38	1,28	1,36	1,18	1,44	1,57	1,62

Skewness (x 10)

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Stykkisholm	−14,7	−3,9	−11,9	−1,4	−0,1	−5,8	−0,5	−3,3	3,3	1,9	−0,2	−1,3
Bodó	0,0	−1,9	−1,9	3,6	0,8	1,7	1,5	4,4	2,1	0,7	−1,7	−3,3
Haparanda	2,5	−1,7	−3,4	−4,4	3,7	5,3	0,9	3,8	1,9	0,8	−2,8	−3,3
Arkhangelsk	−0,6	−2,9	−3,8	−3,0	5,4	2,4	3,3	−1,3	0,0	−4,0	−6,7	−7,0
Wroclaw	−6,6	−15,8	−1,5	0,3	2,2	1'2	−4,2	6,7	−3,5	0,1	−0,1	−7,0
Aberdeen	−3,0	−12,3	0,7	3,5	−0,8	−0,7	0,5	−1,6	−0,5	−3,6	−4,3	−2,0
Oslo	−2,6	−6,8	−3,5	−2,1	5,1	4,1	8,7	8,4	−2,3	2,2	2,2	−0,5
Uppsala	−7,2	−5,7	−3,9	−2,1	−0,3	4,6	5,1	5,1	2,5	2,1	−4,5	−7,7
Helsinki	−5,7	−2,7	−2,7	0,5	2,2	1,8	1,5	5,0	3,4	1,4	−5,4	−7,1
Leningrád	−2,3	−3,4	−2,9	0,4	3,0	1,0	2,2	4,1	5,6	−0,5	−3,5	−6,3
Valencia	−3,8	−8,1	0,5	2,6	−0,2	7,8	4,8	5,3	3,1	−3,3	−3,5	−0,9
Basel	−3,8	−12,2	−1,1	2,0	−3,1	−4,8	2,4	5,7	−2,1	−6,0	2,2	−3,8
Moscow	−5,1	−3,3	−3,7	3,1	−0,6	2,1	4,1	1,3	1,6	−0,4	−2,4	−1,9
Kasan	−2,2	−3,0	−3,9	1,0	−0,8	2,7	4,5	1,8	2,2	0,1	−3,1	−2,1
Sibin	−3,2	−1,9	−3,6	−1,0	−2,2	−1,0	2,8	5,0	−2,1	0,4	−1,6	2,4
Greenwich	−3,8	−9,1	0,8	1,6	−1,6	−3,6	−0,4	3,2	0,6	−3,3	−3,5	−0,2
De Bilt	−5,8	−12,7	−0,2	−1,5	−1,6	1,0	−2,3	4,2	4,6	−2,8	−1,4	−8,2
Berlin	−10,4	−7,1	−0,3	5,0	7,7	6,9	4,0	3,7	4,4	−1,9	−2,5	−5,9
Kiew	−4,0	−6,9	−1,9	0,6	−0,2	−0,9	7,7	4,7	3,1	0,2	−2,3	−4,6
Nantes	−1,7	−8,7	−1,0	4,7	−2,3	−0,3	3,3	5,1	3,4	−3,4	1,4	−7,3
Paris	−3,5	−8,6	−1,5	2,5	−2,7	−1,7	1,8	5,1	2,6	−4,7	−0,5	−5,6
Frankfurt	−6,2	−14,0	−3,1	0,5	−2,7	−2,2	−0,4	4,4	0,3	−2,1	0,5	−0,9
Zürich	−1,4	−10,4	−2,5	2,1	−4,1	−1,2	1,3	6,2	−1,4	−4,5	2,3	−4,8
Wien	−3,5	−12,1	−1,8	0,9	0,8	1,7	−1,8	0,7	−1,5	−3,1	0,3	−5,5
Budapest	−4,2	−9,7	−2,7	1,9	−0,5	2,1	0,0	2,3	−2,1	−0,7	−2,2	−5,5
Odessa	−2,4	−9,5	−2,0	−3,7	0,3	2,4	5,7	5,6	2,4	−1,6	−2,6	−3,5
Marseille	−5,0	−10,0	−2,4	5,0	2,5	0,7	2,8	1,5	−0,6	1,6	1,8	−4,2
Genéve	−2,4	−8,9	−1,3	2,2	−3,0	0,0	3,0	4,3	−2,8	−6,8	1,2	−2,5
Milano	0,6	−10,4	−2,0	3,0	−4,3	−1,6	5,6	0,7	−2,4	0,1	1,8	0,0
Szeged	−4,6	−9,0	−3,4	2,6	0,8	1,3	2,5	3,3	−3,7	−1,5	−2,9	−5,7
Bukarest	−0,9	−5,9	−3,5	−1,2	2,4	1,4	2,3	0,3	1,1	2,0	−2,6	−3,4
Sulina	−1,2	−8,5	−1,5	−4,3	1,1	3,5	3,5	3,6	0,6	−0,3	−2,7	−1,5
Tbilisi	−1,5	−2,2	0,5	6,6	−0,3	−0,1	0,5	0,3	3,4	1,1	−5,9	−6,9
Funchal	2,0	2,3	1,2	0,6	0,7	−1,3	−3,9	5,0	0,9	4,6	2,7	0,9
Lisboa	4,7	−5,7	3,1	3,0	1,5	−1,3	−1,7	1,6	3,9	−0,8	0,9	5,5
Madrid	3,0	−6,3	0,7	4,9	−0,7	−1,6	−3,1	1,6	1,8	−2,0	2,4	2,2
Palma	−1,7	−5,1	1,4	5,6	−0,4	−3,6	8,0	−13,5	−8,7	−0,8	−1,4	−3,7
Róma	0,7	−4,7	−3,7	−4,6	−1,6	−2,4	−1,9	1,6	−1,6	−3,0	0,2	2,9
Taskent	−2,6	−6,9	0,3	0,1	−1,5	−0,9	0,4	−1,4	0,7	−1,4	0,0	−7,1
Köbenhavn	−9,1	−9,5	−2,9	−1,9	−2,0	3,6	−0,2	3,4	1,7	−2,0	−1,9	−3,7

WINTER AND SUMMER TEMPERATURE PERIODICITIES IN BUDAPEST

by

G. Péczely and L. Makra

A tél és a nyár hőmérsékleti periodicitásai Budapesten. A tanulmány Budapest 200 éves (1780—1979) hőmérsékleti adatsorának rejtett periódusait elemzi a harmonikus analizis módszerével.
Az elemzés a téli és a nyári évszak hőmérsékleti adataira vonatkozott. Megállapítható, hogy mind télen, mind nyáron statisztikailag reális periódus mutatkozik 14 és 13 év tartammal, ezenkívül nyáron 36—39 év tartammal is. Legjellegzetesebb a nyári 14 éves periódus, amely Magyarország nyári félévi csapadékában és a magyarországi folyók vízállás adataiban is kimutatható, és szoros kapcsolatban áll az anticiklonális helyzetek gyakoriságának hasonló periódusával.
This study analyses the hidden periods in the 200 years ong (1780—1979) temperature set of data in Budapest.
The analysis referred to the temperature data of winter and summer seasons. It may be concluded that there appears a 13—14 years long period in summer. Among the periods the most characteristic one is the 14-year period in summer which is provable in the water supply data of Hungarian rivers and is in close connection with a similar period of anticyclonic large scale weather situations.

Budapest is one of our observation stations possessing the longest array of meteorological data in Middle Europe. Concerning temperature a homogenised series of monthly mean values is at disposal since 1780. To a more detailed analysis of periodic temperature oscillations this 200 years long observation series is more adequate.

A separate periodical analysis was done for winter temperature set of data (December—January—February) and for summer (June—July—August) set of data as well. *Table 1 and 2* contain the data material of this analysis.

Arranging the time arrays according to the supposed periods of T=3—40 years, with the method of harmonic analysis the constanst of

$$y = A\, sin\left(\frac{2\pi}{T}x + U\right)$$

equitations (A=amplitude, T=the length of the period, x=the passing time, U= =phase angle) the obtained amplitudes were expressed in the rate of

$$E = \sigma\sqrt{\frac{\pi}{n}}$$

expectancy (σ=standard deviation of the data array, n=number of the members of data array). The numerical values of the A/E qoutient gives P probability showing that the amplitude connected to any periodlength should originate from a casual grouping of datas:

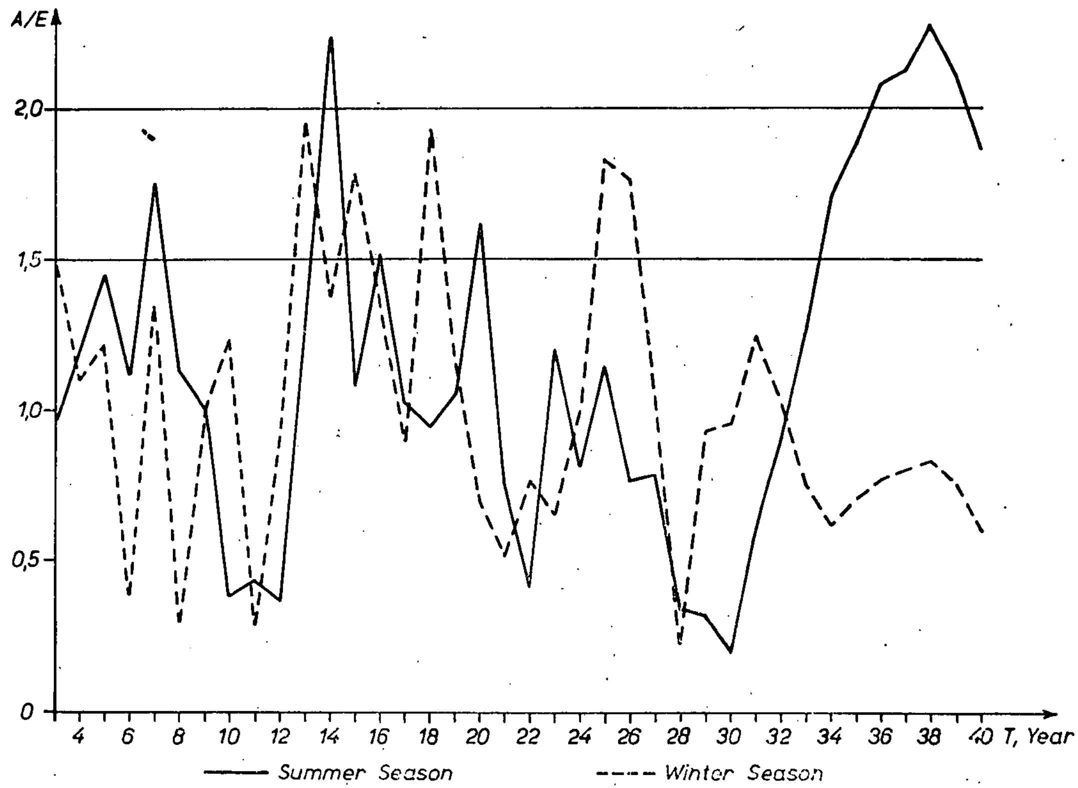

Fig. 1 A periodgram of winter and summer temperature

$A/E=1$	$P=0{,}4559$
1,5	0,1708
2	0,0432
2,5	0,0074
3	0,0009
3,5	$6{,}63 \cdot 10^{-5}$

If P belonging to an A/E quotient is small enough, it may be stated with a sufficient security ($1-P$) that the periode in question is not of incidental quality. If $P<0{,}05$, which is already accepted in mathematical statictics, then $A/E>2$, in the case of a more severe condition, if $P<0{,}01$, then $A/E>2{,}5$ disparities have to be fulfilled.

The results of the period analysis are shown on *Table 3 and 4*. An illustration of obtained results *(Fig. 1)* appears in periodgram

$$A/E=f/(T)$$

With a summing up of data and accepting the $A/E>2$ condition the following facts may be stated:

The realistic periods in the alterations of *summer* temperatures (grouped according to A/E) are: 38, 14, 37, 39, 36 years.

In the temperature array of *winter* only the 13 years long periodicity can be accepted where $A/E=1{,}948$ which is the limit of probability $P=0{,}05$.

The physical reason for these periods are still unknown. It is certain, that they cannot be connected to sunspot cycle and at the same time it can be seen from our analysis that from either data array no realistic period can be connected to the sunspot cycle (11 years).

Now let's devote our attention to the 13—14 years long periods which are discernible in both seasons. These identical periods are quite sharply manifested in the time array of summer halfyear precipitation in Hungary [1], where quotient A/E is 2,5 at T=13 years, at T=14 years 3,56; as well as in the set of data concerning the Danube's water supply on its Hungarian section where at $T=13$ years the values of quotient A/E appeared to be 2,2—2,5, at T=14 years 1,9—2,3 [2]. All these refer to the fact that the 13—14 years long periodicities may be considered general and as a matter of fact only realistic periods of the climatic elements in Hungary. The physical reality of this period is supported by the next examination. Analysing the alterations of the summer halfyear frequency of anticyclonic large scale weather situations in the territory of Hungary it was found that here, too, there is a realistic 14 years long periodicity (the value of quotient A/E is 2,38) and this period is in an almost complete time-synchron with the 14 years long period of summer temperature. The difference between the phase angles of the two periods is only 1°, which shows, that the 13—14-year periodical alteration of the frequency of anticyclic large scale weather situations results in a similar periodical alteration of the summer temperature in the sense that a more frequent appearence of anticyclonic large scale weather situations leads to a rise in summer temperature, while its less frequent appearence to a fall in summer temperature.

Table 1

Mean temperature of the winter months (XII—I—II) °C Budapest

	0	1	2	3	4	5	6	7	8	9
1780		−0,6	−1,3	2,2	−3,2	−2,1	−0,7	−0,6	1,4	−2,5
1790	0,4	2,7	0,7	0,2	2,7	3,1	3,4	0,1	2,1	−4,4
1800	−1,3	0,3	0,8	−1,0	1,2	−1,5	2,6	2,5	0,2	−1,6
1810	1,2	−0,7	−0,8	−2,9	−0,3	1,5	−1,0	1,2	0,9	0,4
1820	−1,3	0,2	2,8	−1,2	2,6	3,0	−0,9	0,1	−0,2	−0,9
1830	−5,0	0,5	1,0	−2,0	3,1	1,6	−1,7	0,4	−4,1	−0,7
1840	−1,0	−4,4	−1,9	3,1	0,0	−1,3	1,5	−1,9	−1,6	0,0
1850	−1,8	0,7	1,2	1,9	−1,4	−0,3	−1,1	−0,8	−3,1	0,7
1860	−0,3	0,3	−1,7	0,4	−2,2	−1,6	1,3	1,5	0,1	1,9
1870	−0,9	−1,6	−1,9	2,6	−0,3	−0,4	−2,0	2,4	−0,1	−0,2
1880	−4,7	−0,9	1,1	0,7	1,4	1,1	−1,3	0,8	−3,1	−0,7
1890	−1,5	−4,4	0,5	−3,8	0,3	−2,3	−2,0	1,0	0,3	2,3
1900	1,2	−2,0	3,0	−0,1	1,1	−0,2	1,2	−1,5	0,7	−1,9
1910	3,0	1,4	1,0	0,1	−0,8	2,5	3,4	0,3	0,6	1,9
1920	2 3	3,0	−0,9	1,4	−0,8	2,0	1,0	1,8	−0,4	−3,6
1930	1,7	1,2	−1,2	−1,1	−1,4	1,3	2,7	0,1	1,1	1,7
1940	−3,7	−1,0	−2,9	0,6	1,8	−0,4	0,5	−2,6	2,6	0,7
1950	1,0	3,5	1,6	1,5	−2,8	1,4	−0,7	1,5	1,5	1,3
1960	1,1	2,1	0,9	−3,3	−2,7	0,1	2,1	1,2	1,2	−0,8
1970	−0,6	1,4	2,9	2,0	3,1	3,4	1,7	2,4	0,9	1,1
1980	1,9									

Table 2

Mean temperature of the summer months (VI—VII—VIII) °C Budapest

	0	1	2	3	4	5	6	7	8	9
1780	20,8	23,7	22,3	22,5	21,9	21,8	20,9	22,2	22,2	21,3
1790	22,5	22,7	22,4	22,2	23,5	21,9	22,3	23,6	22,7	21,4
1800	20,5	20,0	22,7	21,6	21,7	20,1	20,9	23,3	22,5	21,9
1810	20,6	24,1	21,3	19,8	20,8	20,1	19,7	20,8	21,4	21,3
1820	21,6	19,4	22,8	21,3	21,3	21,2	22,3	22,6	21,5	20,3
1830	22,7	20,4	20,8	20,4	24,3	21,8	21,6	20,3	19,8	21,2
1840	20,3	22,0	21,1	20,6	19,9	21,2	22,7	20,9	23,3	20,6
1850	21,7	20,3	21,6	21,7	20,7	22,0	21,3	22,0	22,6	22,9
1860	20,5	22,7	21,5	22,2	20,2	21,5	21,7	20,9	22,4	21,1
1870	20,1	20,7	20,8	21,9	22,0	22,3	21,6	21,1	20,4	20,6
1880	20,7	21,0	19,5	20,5	19,7	20,9	20,8	21,1	20,3	21,4
1890	21,2	19,9	21,8	20,0	21,0	20,6	20,7	21,2	20,6	20,0
1900	21,0	21,6	20,2	20,2	22,0	22,4	20,5	20,3	20,9	20,7
1910	20,8	21,7	20,3	18,7	19,8	20,1	19,8	22,6	19,7	19,8
1920	19,8	21,1	21,1	20,2	20,2	20,2	19,3	21,8	22,1	21,5
1930	21,5	22,0	21,3	20,6	21,5	21,6	21,1	21,4	21,8	21,8
1940	19,8	20,0	20,8	21,4	21,0	21,8	22,8	22,6	20,3	20,5
1950	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Table 3

Periods of series of winter months' temperature

T	A	U	A/E	T	A	U	A/E
3	0,3487	238,6	1,4864	22	0,1806	179,8	0,7698
4	0,2584	283,7	1,1014	23	0,1503	293,1	0,6407
5	0,2846	33,2	1,2131	24	0,2354	96,5	1,0034
6	0,0885	50,5	0,3772	25	0,4304	184,3	1,8346
7	0,3175	307,9	1,3534	26	0,4134	249,1	1,7621
8	0,0700	44,0	0,2984	27	0,2476	293,2	1,0554
9	0,2369	148,9	1,0098	28	0,0569	171,5	0,2425
10	0,2897	297,4	1,2349	29	0,2173	238,1	0,9263
11	0,0656	99,7	0,2796	30	0,2248	276,1	0,9582
11	0,0656	99,7	0,2796	30	0,2248	276,1	0,9582
12	0,2159	107,1	0,9203	31	0,2934	330,2	1,2506
13	0,4570	104,2	1,9480	32	0,2438	20,2	1,0392
14	0,3263	157,7	1,3909	33	0,1758	83,0	0,7494
15	0,4213	159,9	1,7958	34	0,1453	155,6	0,6194
16	0,3198	259,2	1,3632	35	0,1653	207,9	0,7046
17	0,2121	30,2	0,9041	36	0,1797	249,8	0,7660
18	0,4529	211,9	1,9305	37	0,1857	282,8	0,7916
19	0,2765	343,7	1,1786	38	0,1965	313,8	0,8376
20	0,1651	201,1	0,7038	39	0,1749	333,6	0,7455

Table 4

Periods of series of summer months' temperature

T	A	U	A/E	T	A	U	A/E
3	0,1194	294,0	0,9676	22	0,0519	264,6	0,4206
4	0,1476	217,6	1,1961	23	0,1475	341,0	1,1953
5	0,1784	308,3	1,4457	24	0,1006	59,9	0,8152
6	0,1378	195,4	1,1167	25	0,1418	111,0	1,1491
7	0,2163	268,0	1,7528	26	0,0946	179,6	0,7666
8	0,1403	194,7	1,1370	27	0,0977	244,0	0,7917
9	0,1240	314,3	1,0049	28	0,0421	282,2	0,3412
10	0,0466	179,0	0,3776	29	0,0390	305,8	0,3160
11	0,0533	258,1	0,4319	30	0,0253	259,5	0,2050
12	0,0452	303,9	0,3663	31	0,0735	248,7	0,5956
13	0,1673	23,6	1,3558	32	0,1112	259,6	0,9011
14	0,2766	107,8	2,2415	33	0,1559	276,7	1,2634
15	0,1332	27,8	1,0794	34	0,2124	293,9	1,7212
16	0,1872	144, 5	1,5170	35	0,2323	310,3	1,8825
17	0,1268	167,4	1,0276	36	0,2575	327,6	2,0867
18	0,1172	289,4	0,9498	37	0,2631	355,0	2,1321
19	0,1300	163,0	1,0535	38	0,2823	0,0	2,2877
20	0,2004	280,0	1,6240	39	0,2606	18,7	2,1118
21	0,0943	17,5	0,7642	40	0.2308	38,1	1,8703

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